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COSMIC EVOLUTION • A SONG
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Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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DEPARTMENTS

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Malvina Reynolds

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Robert Jastrow

David W. Kirtley

Nancy Modiano

MALVINA REYNOLDS received her Ph.D. in English from the University of California at Berkeley in 1939. Since that time she has composed and recorded numerous songs, the lyrics of which are generally social critiques combining humor, indignation, and irony. She has written three books of songs, *Little Boxes and Other Handmade Songs*, *Muse of Parker Street*, and a children's songbook, *Tweedles and Foodles for Young Noodles*, selections of which have been recorded in an album by Columbia Records. In addition to her affiliations with the American Federation of Musicians and the American Society of Composers, Authors and Publishers, she belongs to the Sierra Club and the Wilderness Society.

ARNOLD ROSS of The American Museum of Natural History's Department of Living Invertebrates steps out of his usual role as a student of mollusks, crustaceans, and echinids of the Quaternary to bring the readers of NATURAL HISTORY an article based on his avocation—stamps. Ross has done an extensive monograph on the deep-sea barnacles of Antarctica and is affiliated with such professional societies as the American Institute of Biological Sciences and the Paleontological Society of America.

ROBERT JASTROW is concerned with the infinite—the infinitely small, as when he analyzed experiments on the scattering of protons by protons at high energies, and the infinitely large, illustrated by his investigations of the upper atmosphere and the creation of the universe itself. Now the Director of the Institute for Space Studies, an office of NASA's Goddard Space Flight Center in New York City, he is also Adjunct Professor of Geophysics at Columbia University. Dr. Jastrow, who received his Ph.D. from Columbia in 1948, has a deep interest in the science education of young people and serves as Chairman of the Junior High School Science Curriculum of the American Association for the Advancement of Science. Jastrow is author of the 1967 Harper & Row book *Red Giants and White Dwarfs*.

DAVID W. KIRTLEY worked for thirteen years as a petroleum geologist after graduating in 1950 from Phillips University in Enid, Oklahoma. Then, after two years as a high school teacher, he returned to finish his M.S. at Florida State. Presently he is a predoctoral intern at the Smithsonian Institution and has been conducting extensive research on worm reefs along the coasts of the Western Hemisphere, work that has been supported in part by the Society of Sigma Xi.

French-born PATRICK MENGET came to the doctoral program at Harvard University from the University of Paris where he holds the Licence ès Lettres with honors and a Diplôme in that school's Political Institute. His primary interest is in the anthropology of South America, particularly in the societies of central Brazil. At Harvard he has been a Teaching Fellow in the Department of Social Relations and in the Department of Anthropology. Currently in Brazil doing field work supported by the Harvard Chiapas Project under the direction of Dr. Evon Z. Vogt, Menget has two manuscripts in preparation, which provide further insights into the customs of the Chamula: *Chamula Shamanism* and *Chamula Death Ritual: Structural Analysis*.

NANCY MODIANO has chosen to study the developing child in an educational framework, and has done so in some detail in this country and in Mexico. Between 1959 and 1963 she taught fifth-graders at the American School in Mexico City, taught education at Mexico City College, then became Research Assistant in Child Development to Dr. Erich Fromm at Cuernavaca. Dr. Modiano (New York University, '66) is active as a consultant to several New Jersey and New York school districts and to New York City's Project Head Start. Her article "A Chamula Life" has a lyrical quality that is rare in educational reporting.

A Song of San Francisco Ba

The highway is laid as smooth
as glass
For miles and miles and the
cars can pass.
But the ant and the bee and
the bush and the tree
Whose home it was are now
exiles.
And the cars rush by for miles
and miles,
To find a place where they
can see
A plant, a bush, and a blade
of grass,
And a ladybug, and a bee.*

Of the 270-odd miles of shoreline of San Francisco's great bay, some—not much, but some—is still in its natural state: grassy or lightly wooded hills leading down to a rocky border; marsh and tidelands green with reeds and salt grass, still alive with sea and shore birds and the infinite smaller creatures who populate such places. And if you wanted to see something like this, you might take a thirty-mile drive along the bay's northern shore—say on Highway 37—between Vallejo and San Rafael, with no towns between. If you'd been there before, a few years ago, you would remember a long stretch of secondary road a few feet above tideland level, with open marsh or farmland on both sides and the bay itself stretching to the south.

But now on that route you would find no bay, no marshes, not even farms for miles beyond Vallejo. Just the usual decorations of the modern highway—auto junkyards, hamburger stands, motels, small factories, billboards, gas stations—and the bay not even in sight. So you might take one of the unnamed roads that heads south to where the bay should be, and you could find yourself in the enormous grounds of the Kaiser Steel plant. Driving into the grounds you'd go over a bumpy road through an expanse of raw ocher earth, with a lonely bunch of reeds in a small pool at a culvert showing what had been here before the steel mill took over. As far as the eye can see, lines of flatcars on the spur track carry monster steel pipe probably destined to provide drainage for the new highways that are being laid everywhere you look.

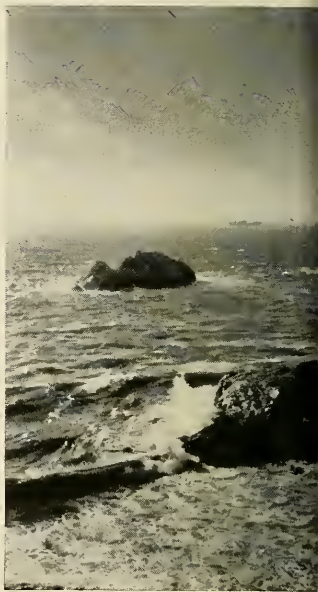
This isn't what you were looking for, so you bump back on the branch road to 37, into the roaring raceway of cars, heading westward again. It is ten miles or more before you finally reach open fields and then the marshes, with reeds and salt grass and, for the first time this trip, the cool wind that blows from the bay and across the flats.

After a while you want to stop, but it isn't easy to turn off, with the heavy traffic averaging 50 miles an hour, and some people might wonder why anyone would want to stop here anyway. No garage, no hot dogs, no bar—the cars all tearing by, headed some place. But it happens there are white herons feeding not far from the road, and you hope to get them with your camera. They have become accustomed to the heavy trucks roaring by and the endless line of cars. But you have to come up easy with the camera—they are not accustomed to people on foot.

*

Seventy miles of wind and spray,
Seventy miles of water,
Seventy miles of open bay—
It's a garbage dump.†

I wrote the song "Seventy Miles" in March of 1965. For me, it marks the first time I became sharply aware of what was happening to San Francisco Bay—my bay, everybody's bay.



In a way, San Francisco, port to the coast trade and the Orient, takeoff point of the gold rush of the 1850's, commercial center of the mineral and agricultural wealth of the state, is everybody's city. Will Irwin's *The City That Was*, a little "requiem of old San Francisco," written in 1906, three days after the great earthquake and fire, opens with a quote from one Willie Britt, "I'd rather be a busted lamp post on Battery Street, San Francisco, than the Waldorf-Astoria." And Irwin himself describes the city of those days as "The gayest, lightest hearted, most pleasure loving city of the western continent." Fifty years later, Joseph Henry Jackson, book reviewer of the *San Francisco Chronicle*, opens his booklet tribute *My San Francisco* saying, "San Francisco is a great and greatly loved city."

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†From "Seventy Miles," words by Malvina Reynolds, music by Peter Seeger. Copyright © 1965 by Abigail Music Co., (BMI).

Malvina Reynolds

A ship (left) wends its way toward the Golden Gate and the bay, where the process of landfill (above) threatens destruction of San Francisco's scenic harbor.

Songs are written about San Francisco in every generation; visitors who come here go back home to pack their belongings and get out here to live. Whether they came with the covered wagons, with the railroads, with the gold-rush pioneers; as servicemen in many wars, as workers in war industries, or just as summer tourists running away from the muggy heat of other parts of the country—they settled here at last. Areas around the metropolises of the West Coast are among the fastest growing communities in the world.

And even if they don't get here to live, if they have only visited or if San Francisco is only a name to them, they feel a sense of identity with this city; it is part of the romantic tradition of America and the West. But I was born here. Grandparents on my mother's side were pioneers who left Lithuania in the 70's and, rejecting the East Coast, came directly to San Francisco. My father came alone from Budapest when he was fourteen. I was born south of Market Street in San Francisco—now an area of small industries and wholesale houses, but then a respectable lower-class section of wooden railroad flats, a few of them still standing among the warehouses and plants. I have lived in this city or near it most of my life. As the saying goes in this town, "Why should I go anywhere? I'm here already."

The bay and the hills around it are part of my natural environment, as they are of most of the three million who now inhabit the bay counties. Until about 1965, I had taken this great inland sea for granted. But all the time, it was being edged in on.

One of the maps in the office of the San Francisco Bay Conservation and Development Commission is a colored layout of the bay area showing the landfills that have been made since 1860. By 1900, when I came on the scene. the three coves that had sheltered sailing ships on the eastern side of San Francisco peninsula had been largely filled and built over. Later, while earning my degrees—and learning how to have fun—at the university in Berkeley, agents for farm land were filling about twenty square miles of mud flats and marsh in the northeastern arm of the bay; and under my eyes, as I crossed back and forth on the new transbay bridge, a whole new island had been laid in the shallows next to Yerba Buena Island, to accommodate first a world's fair, and then a Navy base. Some square miles on the eastern shore, south of Oakland, had also been filled.

In 1940, my husband Bud, a construction worker, was up to his ankles in mud, working on the shipyards that would be part of a continuing extension of the town of Richmond, jutting out from the bay's east shore. In 1942 and 1943 he worked on the Oakland Naval Base, which, with the adjacent Alameda Naval Air Station, thrust fill and docks for a mile or more into the bay alongside the East Bay bridge approach. At the same time the San Francisco airport, built on fill at the south end of the bay, was granted an extension of submerged lands. Ten years later, 7,000 acres of tideland would be granted to Oakland for its airfield. Two beautiful small bays on the northwest shore, in Marin County, had been converted from jewels reflecting Mount Tamalpais and the wooded

foothills into flat, dirt-filled areas with a few buildings for decoration.

Free fill supplied by the Army Engineers from the dredging of the bay bottom was part of the material used to make these continual fills. More came from hills that were being leveled for factories and housing sites. The most offensive was garbage. At this writing, the city of San Francisco still dumps its tremendous daily load of garbage into the southern end of the bay, in spite of a valiant fight by people of the city of Brisbane, on the face of San Bruno Mountain and overlooking the flats, against the offense in their front yard. There are more than thirty refuse disposal sites in and at the edge of San Francisco Bay, from Martinez and Pittsburg on the northeastern arm to Palo Alto and Alviso at the south. And the discharge points for sewage and other fluid wastes, domestic and industrial, are about three times as many.

Because the mountain formations of the West Coast run generally north and south, there are very few good harbors on the Pacific. San Francisco Bay is the largest and finest south of Puget Sound, a water area at mean high tide of more than 435 square miles, almost completely protected from the sea except for the strait on the west called the Golden Gate. The bay itself lies in what was a long valley, extending north and south. Into its northern arm empty two big rivers of the Central Valley—the Sacramento, flowing south, and the San Joaquin, flowing north.

More than 400 square miles of open water. But when California was admitted to the union, before any "sanitary landfill" had been dumped into the bay, its area was more like 700 square miles. If you tell the average San Franciscan that the bay is one-third smaller than it was when discovered, he will be startled. And if you tell him that a good deal of the rest of the bay—and I am talking of water-filled bay as far out as the deepwater boating channels—is city, county, state, or privately owned real estate, marked into lots and changing hands at ever rising prices, he will question your sanity. But it's true. Mel Scott, Research City Planner commissioned in 1963 by the Institute of Governmental Studies of the University of California at Berkeley to do a study on the future of San Francisco Bay, tells of the ownership of these submerged tide and water lots in the bay: "Almost the entire waterfront of Sausalito has been consolidated by a single syndicate. Just seven owners now control the submerged properties in Corte Madera Bay, among them the Marin Title Guarantee Company, the Utah Construction and Mining Company, the Wells Fargo Bank and the City Title Company. . . . On the eastern side of the bay the Santa Fe railroad has title to almost all the privately held tide and submerged lands from Richmond to Oakland, and in Richmond alone it owns 1,156.13 acres. The Standard Oil Company possesses more than a thousand acres of offshore properties in Richmond, and claims title to another 640 acres." And so on and on. I sat on the deck of my friends' pleasure boat in the Sausalito Yacht Harbor on a pleasant Sunday afternoon, and they pointed to a section of the bay, far from shore, where yachts and trimarans were sailing by. "A lot out there," they said, "just changed hands at a price of $600,000."

"For eleven decades," says Scott, "the state government has tended to regard the bay as property rather than as a great natural resource to be safeguarded." While the state still owns the greater part of the northern arms of the bay—Suisun and San Pablo bays—it is in possession of less than half of the main body of the bay.

This process of local and private occupation of underwater real estate and tidelands began even before California became a state, with an edict issued in 1847 by Brigadier General Stephen W. Kearney, military governor of the territory, for the sale of submerged lands in Yerba Buena Cove at public auction—"proceeds for the benefit of the town." The cove exists no longer, but is filled from Montgomery Street, San Francisco's Wall Street, to the Embarcadero, the wide avenue along the bayside docks. It now supports a sizable part of the downtown city.

They say the filling process began, perforce, when ships of the '49 Argonauts were abandoned in the cove, a whole fleet that had come around

the Horn and anchored there—the first no-deposit, no-return throwaways in the state's history. Some of them sank and are part of the underlay of tremendous office buildings; others were used as temporary dwellings and business places in the exploding town of the mid-century, and the area around them was filled for foot and carriage passage. The ship *Apollo* became a saloon; the brig *Euphemia* served as a prison ship.

At any rate, the process of private ownership of the bay was made official by the Army officer who is generally forgotten even by those who use busy downtown Kearney Street, which is named for him. And the process has continued under confused authority, until we have the situation described by Mr. Scott, with much of the bay now in title deeds. The agencies trying to hold the line against filling of the bay have to battle these holdings, foot by foot.

At first thought, to a tenderfoot like me, much of the bay would seem to be of questionable value in its native state. A good deal of it is quite shallow even at high tide, and the U.S. Army Corps of Engineers, with the engineer's practical eye, describes 248 square miles of tidelands as "susceptible of reclamation."

You will excuse a poet's digression here. I am sensitive to words like *reclamation* and *development* because they are not, as they would seem to be, impersonal and descriptive. They are highly charged with propaganda. My dictionary says of "reclaim": "to bring back to a useful, good condition." and two common uses of the word are given in the quotations that follow: "The farmer reclaimed the swamp by draining it." "Henrietta reclaimed him from a life of vice."

We are to believe that the dumping of waste and garbage into the edges of San Francisco Bay, the covering of it with the bedrock of ravaged hills, is a reclamation.

The building of housing and businesses would at first thought fulfill the idea of "development," which Webster's Twentieth Century Dictionary describes as "the causing to become gradually fuller, larger, better."

But the development of the bay region has one immediate, adverse effect. In a crowded part of the world, it puts people in residences and in factories where there were no people before. All the harmful results of overpopulation are immediate—increased strains on waste disposal facilities, increased appearance of pollutants in air and water, increased demands for highways and parking facilities, increased psychological damage from crowding.

But the shallows and mud flats in their natural use have values of their own. It does not take an expert to know that open space is a great value in itself. When it carries bay and ocean breezes, sweetened with oxygen and natural moisture, it is even more precious. And the mud flats and marshes are in themselves producers of oxygen. Mud algae, exposed to sun and water, produce oxygen for air and water. So do the marsh plants, the tules and the marsh grasses. The latter are very rich in food value for the sea and bay creatures that feed on them as the plants die away. Cord grass, one of the marsh plants, has seven times the food value of an equivalent acreage of wheat, and in the cycle of life that goes on in the waters of the bay and the ocean, these food values insure a rich crop of fish and other sea food for the multimillion-dollar sport and industrial fisheries.

I'm sorry to find myself talking in money terms. But every agency that fights for preservation of our bays, rivers, and forests finds itself having to appeal in such terms to the governing bodies—city, state, and national—that have these decisions in their hands. Otherwise, they can be accused of "catering to the bird watchers."

The bird watchers—there's
a laugh.
Their idea of having fun,
Sitting on a hillside under
the sky,
Sensing the trees and feeling
the sun,
Watching the birds who nest
and fly,
Watching the castle clouds
go by,
Watching the flowers, watching
the bee,
When they could be sitting at
home with a beer,
Watching T.V.

Besides being the home of many local characters—sea gulls, pelicans, herons, cormorants, and loons—San Francisco Bay is the stopping station for hundreds of thousands of birds on the Pacific flyway, a run that ex-

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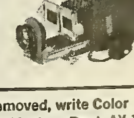

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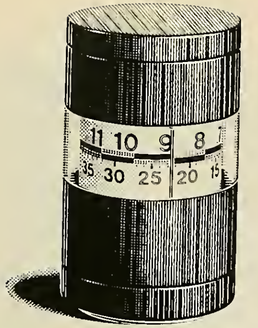

tends from South America to the Arctic Circle. The marshes and waters of the bay, where the water is less than eighteen feet deep at low tide, are the principal feeding, resting, and wintering grounds for seventy-five different species of water birds that visit and live here. Mussels, clams, snails, worms, and insects are the main of their diet; the deep waters of the bay are their playground and their shelter during storms at sea. The bay has a great fish population, too, and many species that live in the sea come to these shallows to spawn. The young feed on the marsh and mud flat life, and vice versa.

There are about fifty square miles of marshland remaining around the bay, sixty-five square miles of tidal flats, and seventy-eight square miles of land at the south end of the bay that are used for salt production—commercial, indeed, but still an open area and one that sustains certain water creatures adapted to the concentrations of salt in the drying pools.

But if, in your scenic drive, you missed the way to Highway 37 and came to the new bridge over the Napa River, which feeds into the bay from the north, you would find inroads into the open areas—new highway being laid over the marshland; raw yellow earth over a wide swath of what had been reeds and pools and small sea creatures. A poet sitting by the driver of the car might have scribbled in his notebook:

> Goodbye to the reeds and the
> little fishes,
> And the shouting boys who
> play under the bridges.
> Raw earth dug from the doomed
> hillside
> Pours over the marsh grass,
> child of the tide;
> The living wind that blew
> from the bay
> Now carries the fumes of the
> swarming highway.

And at scores of places on the bay shore, and notably at the south end, eight thousand tons of assorted garbage—trash and the stones and waste of demolished buildings—are daily dumped into the bay.

We are generally an affluent and wasteful people, and each one of us produces his four pounds of discards a day—not to mention sewage and the products of industrial waste that our consumption of stuff requires.

What to do with all this? I don't know. I only know that a civilization that can send men to the moon can certainly find other ways of handling this problem than by destroying a city's greatest natural resource for a dump. I read somewhere about a European city that consumes its waste under very high heat, and presses the resulting slag into building blocks. What a great idea! If this is so, then maybe it doesn't have to fell its forests for building materials, either. Apparently there are many kinds of engineers in the world.

The tone of my discourse, so far, would indicate that I favor pelicans, wild geese, striped bass, and sea snails over human beings. I would hate to be pushed too far on this question, but it is really not relevant, because people and pelicans alike live much better lives as one in the life-chain with marsh grass, ladybugs, forests, robins, wild blackberries, and shrimps. If more people were packed into the space already marked off in the bay as real estate, they'd all be worse off than if they had never come here in the first place. California is a tremendously large state, and there are millions of acres that could absorb any normal increase in population. That is, if we weren't all city-oriented, which is another question.

The great pulse of the ocean tides sweeps into San Francisco Bay twice a day, and ebbs out, to create a tremendous circulatory system, which cleanses the bay waters, aerates the waters and mud flats, and feeds the creatures who depend on this tidal change for their environment. Meanwhile, fresh water from the Sacramento and San Joaquin rivers flows into the north end of the bay, sometimes over the salt water beneath. In the central area of the bay the ocean tides can often be seen moving in over the underlying fresh water, and underneath are tremendous currents caused by these pulls and drifts, as well as by the contours of the bay's edges and bottom. The oxygen content of the water is affected by these movements, and on this content depends the ability of the waters to handle and convert the outflow from the cities, to prevent the waters from becoming lethal to wildlife and people. Every reduction in the area of the bay works against this function, and about now, the margin of safety is pretty small. Four and a half parts of oxygen per million of water are

necessary for the survival of the fish and other creatures of the bay waters. It now stands at an average of something like seven to nine and a half parts per million—and the garbage trucks and dump trucks are running down the Bayshore Freeway all day, every day, while the Engineers offer free fill to all who want it.

According to the San Francisco Bay Conservation and Development Commission, if all the relatively shallow parts of the bay shown by the U.S. Army Corps of Engineers to be "susceptible of reclamation" were filled (and, as we have seen, about 25 per cent of the bay, including most of the shallow areas nearest the shore, is claimed by private owners), the bay would consist of only 187 square miles. In some places it would be little more than a river. The rest would be what Harold Gilliam, feature writer of the *San Francisco Chronicle,* calls, in an article in the Sunday magazine of March 7, 1965, a "fuming flat." The local provincial patriots among the conservationists fearfully describe the resulting place as "another Los Angeles." I am something of a neutral in this conflict between cities, but I think they may have something.

Anyway, what I think of the fill projects—and every county, every owner of submerged land in the area, has such projects in blueprints—opens the song, "Seventy Miles."

> What's that stinky creek
> out there,
> Down behind the slum's
> back stair,
> Sludgy puddle, sad and
> gray?
> Why man, that's San Francisco
> Bay!

Harold Gilliam, quoted above, is one of the great naturalists of the Pacific Coast, and a favorite columnist on San Francisco's only major morning paper. His work on San Francisco Bay, published in 1957 by Doubleday, is a learned and poetic tribute to what he calls "the incomparable harbor." Each section of the book opens with a lyric painting of a particular aspect of the bay, its hills, and its sky.

"Clouds hang low over the vast amphitheater of the bay and its shores like a pavilion roof supported by mountain pillars. The scene is a monochrome of grays of infinite shadings from silver to near-black.

The morning air is still, and the bay is flat and glassy—a clean scroll ready to be written on by the winds, the fogs, the rain, and passing vessels.

"A freighter leaves a spreading V-shaped wake of waves and ripples sharply etched on a surface of gun-metal gray. A tug crosses the ship's wake and sets up a conflicting series of wave lines. . . ."

And, in another area of literature, John Phillips, songwriter member of the Mamas and the Papas, sings:

> If you are going to San Francisco,
> Be sure and wear some flowers
> in your hair.*

Too bad, too bad, that we have to talk of garbage, and the proposed tearing down of a mountain (the only one in the southern area of the bay, San Bruno Mountain) for fill to eradicate another swath of this great inland sea. It is too bad that we have to talk of sewage outlets, of "industrial parks" and freeways and housing developments projected for the precious wild spaces that still remain and even for the deepwater areas within the bay.

But I am not the only one by a long way who "came to" in the early sixties as to what was happening to my bay. I discovered, when I looked around, that many conservation organizations were actively concerned, that leading citizens of the area had formed a Save the Bay Committee, that the counties adjoining the bay had realized that some measure of joint planning was necessary to prevent the disaster that they were all beginning to foresee otherwise. There is now an Association of Bay Area Governments, a Bay-Delta Water Quality Control Program, a Citizens for Regional and Recreational Parks, and under the aegis of the state legislature, a Bay Conservation and Development Commission. There is a moratorium on filling—not complete, as we have seen, but a hopeful start—while BCDC prepares and presents its recommendations. The concept of development is included, granted—but at least some of this development seems to be in the direction of rescuing the few miles of publicly owned bay shore for public parks, adding to these miles by purchase where it's possible.

The eastern arm of Richardson's

Bay, one of the bays within the larger bay, was recently threatened with development as a private residential marina, but conservationists raised a quarter of a million dollars, bought the place, and then turned it over to the Audubon Society as a wildfowl sanctuary.

Though there are constant pressures for easy airfield extensions, building sites, highways, and dumps into this great open bay's shallower areas, there is hope that most of it can still be rescued. I had occasion to engage in a similar conflict in 1964, when the state Highway Commission (autonomous and arbitrary until it has become a statewide scandal) was determined to run a freeway through Golden Gate Park Panhandle—a beautiful approach to the city's largest and most famous park—a park that graced and gave play and open green area to a heavily populated section of the city. It was only a small group of citizens that initially opposed this move, and many who were aware of the strength and resources of the interests favoring the freeway plan thought they didn't have the hope of a chance. But more and more came in to help the little band of conservationists. The *Chronicle* backed the campaign, and called a big rally in the park's Polo Grounds. Even I was called on to come and sing my song "Little Boxes," which I was glad to do. But just before the rally I also wrote "The Cement Octopus." and I sang that, too. At this writing, after several years, the Panhandle still remains a park. A year after the first victory, a little group of us met in the Panhandle in the rain to celebrate and plant a small new tree there among the giant conifers and eucalyptus that had been planted by John MacLaren, who created the park in the preceding century.

And talents and dedication of all kinds rally in defense of the bay. The Bay Area Photographers do a whole season's show on the bay, and contribute prints to the Save the Bay Committee. Junk sculptors construct art works on the east bayshore flats, littered with flotsam, tires, cans, and other trash, as a sort of mute plea for something creative, some joy for the eye, to come out of this senseless ravaging of the bay. The songwriters sing of San Francisco, and the patriarch of folksingers, Pete Seeger, in his Columbia album devoted to conservation (the great conservationist Justice Douglas does the album notes for "God Bless the Grass") sings our song, "Seventy Miles."

What's that stinky creek
 out there,
Down behind the slum's
 back stair,
Sludgy puddle, sad and gray?
Why, man, that's San Francisco
 Bay!

Chorus:
Seventy miles of wind and spray,
Seventy miles of water,
Seventy miles of open bay—
It's a garbage dump.

Big Solano and the Montecell',
Ferry boats, I knew them well,
Creak and groan in their
 muddy graves,
Remembering San Francisco
 Bay. *(Chorus)*

Joe Ortega and the Spanish
 crew,
Sailed across the ocean blue,
Came into this mighty Bay,
Stood on the decks and cried,
 "Ole!" *(Chorus)*

Fill it there, fill it here,
Docks and tidelands disappear,
Shaky houses on the quakey
 ground,
The builder, he's Las Vegas
 bound. *(Chorus)*

"Dump the garbage in the Bay?"
City fathers say, "Okay,
When cries of anguish fill
 the air,
We'll be off on the Riviere."

Chorus:
Seventy miles of wind and spray,
Seventy miles of water,
Seventy miles of open bay—
It's a garbage dump.

We are working out here to guarantee that this song becomes obsolete—a curio.

Captives and Cultigens

by Marston Bates

Every once in a while I become enamored of some technical term. "Cultigens" is a good example. I would use it to replace the awkward phrase "cultivated plants and domesticated animals," including any kind of organism maintained by man and genetically modified to fit human needs or whims through the process that Darwin called "artificial selection."

My rather feeble efforts to track down the origin of the word *cultigen* have not been successful. It is included in *Webster's Third New International Dictionary* with the definition "a cultivated organism (as maize) of a variety or species for which a wild ancestor is unknown." There is no indication of the history of the word in this dictionary and in others I have checked. I don't see the point in limiting its application to species of unknown ancestry. Often whether or not the ancestry is known is a matter of debate or opinion. Look at the dog, the oldest and one of the best studied of man's cultigens. One can argue that the domestic species is descended from some now-extinct kind of canine, from one of the living wild species, or from a mixture of several types (this last seeming most probable to me).

I like cultigen because of the various games that are possible with the word. Species that have become so modified that they can no longer survive without human help can be classed as "obligate cultigens." Maize is one of these; how could it get along without people to husk the ears, remove and sow the seeds? Plants and animals that can escape from human care to run wild would then be "facultative cultigens"—a nicely elegant phrase.

Cultigens by definition are closely associated with man. Before looking at them in more detail it may be useful to consider the other groups of organisms that share this characteristic—the animals, plants, and microbes that make up "the human entourage." Cultigens for the most part form an easily distinguished category, but they do at times blur with the organisms kept or raised by man that have not been genetically modified by this process. Most zoo lions are descended from zoo ancestors, but I would hardly call them cultigens, tame and innocuous as they may be. Then there is the problem of what to call the animals trapped in the wild and sold in our pet shops; or the wildflowers that we often plant in our gardens.

At one time I tried to distinguish the forms that had not been genetically modified through human action as "pets." This system would make kittens cultigens and cacti growing in a rock garden pets. I am ready to give up on that. The meaning of *pet* as an animal kept for pleasure rather than utility is too firmly established an[d] too useful. Dogs, cats, lambs, ra[c]coons, monkeys, parrots—all may b[e] pets. I suppose house plants coul[d] also reasonably be included.

What, then, should we call the ani[-]mals and plants that man keeps pur[-]posively, but that he has not modifie[d] through breeding? "Captives" i[s] about the best I can do. This term would cover both the animals in zoos and the plants in botanic gardens, as well as the monkeys in New York apartments and the parrots in forest huts. Most of the animals and plants in my "experimental rain forest" are captives rather than cultigens, which is one of the things that have interested me in the modifications brought about by human manipulation.

Man acquires cultigens and captives on purpose. But there are also many animals that move in on man whether he wants them or not—like

Flowers are vital adornments for the natives of Ifaluk, a Pacific atoll.

handful of people like Mary Carnwath
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t they won't make it without you.

he Hopi Indians' village of
ılovi in Arizona sits on land
or, infertile and inhospitable
 far nobody has tried to take
y from them.
ectricity has not yet reached
opis. Water must be hauled
hree miles away. Jobs are few
r away. Only poverty and des-
re close-by and in abundance.
et for the first time in genera-
 Mary Carnwath and people
er are stirring hope among the
.
Iary Carnwath works and
two thousand miles away, in
ıattan. Her own daughter is
grown-up, and through *Save
hildren Federation* she is spon-
g one of the village girls, 8-year-
race Mahtewa.
he Mahtewas (two parents,
 children, one grandmother
a sister-in-law) live tightly
ed in a tiny rock and mud
. The father who knows ranch
 but can't find any most of the
isn't able to provide the family
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the cockroaches in our house, described by my wife a couple of months ago. It seems to me that the best word for this group of animals is "inquilines," a word first proposed for the various special insects that make their homes in the nests of ants, bees, and termites. Man's inquilines include a variety of insects and sundry kinds of rats and mice.

The inquilines live with man, and indirectly off him as well, feeding on refuse, garbage, and stored food when they can get at it. There are also many organisms that use man himself as food: bedbugs, lice, fleas, and a whole catalogue of worms, fungi, protozoans, bacteria, and viruses. These are easily labeled "parasites."

Man's entourage also includes a considerable variety of animals and plants that are only indirectly associated with him—taking advantage of the open habitat created by clearing and planting land. Squirrels belong here, as well as various birds with habits like those of the American robin. The plants that we call "weeds" depend on man to clear space for them. Such organisms might be called "opportunists," since they take advantage of the opportunities resulting from human activities.

But I started to write about cultigens before getting off on this more general problem of classification. The origins of our major crop plants and food or draft animals are lost in prehistory, and while a host of experts—archeologists, geneticists, geographers, and various kinds of botanists and zoologists—have become concerned with how agriculture may have started, we shall probably never be sure about the beginnings. Current ideas are summarized in three books that I have found useful and informative: Carl Sauer, *Agricultural Origins and Dispersals* (New York: American Geographical Society, 1952); Frederick E. Zeuner, *A History of Domesticated Animals* (New York: Harper & Row, 1963); and Franz Schwanitz, *The Origin of Cultivated Plants* (Cambridge: Harvard University Press, 1966).

The curious thing is that within historic times we have not developed any major new sources of animal or plant food. Did our ancestors discover all of the possibilities? Or have we lost contact with nature and ceased to explore and experiment, despite our vaunted knowledge and scientific methods? We have, to sure, made great advances in agricultural productivity in recent yea through the application of scien and technology—but the improv ments have involved traditional cro and animals. A number of peop have recently suggested that the me production of African savanna would be considerably greater usin the diverse native fauna, rather tha replacing it with imported cattle a has been the practice. But I know o no completed experiments with th breeding and management of suc animals.

There are three areas, however, i which we have been acquiring nev cultigens in modern times: garde flowers, laboratory animals, an tropical fishes. These three groups o organisms are all but ignored in th standard books on the origins of cultigens, although I should think studies of them might throw light on the nature of domestication.

I find the neglect of the history of garden flowers particularly puzzling. There is a fine little book by A. W. Anderson, first published in 1951 and currently reprinted by Dover Publications, on *How We Got Our Flowers*, but it deals mostly with modern exploration and with horticultural achievements. What kind of flower gardens did the Greeks and Romans have; or the ancient Chinese and Japanese, since their modern descendants are so much devoted to gardening? What flowers grew in the Hanging Gardens of Babylon?

Garden books and encyclopedias seem to me to be remarkably negligent of history, except for developments in modern times, and I have been largely frustrated in my attempts to find out about ancient gardens. Flowers are, to be sure, trivial from the point of view of world or local economy, and it may be for this reason that they are not often mentioned by writers—flowers are more apt to be taken for granted than basic foodstuffs.

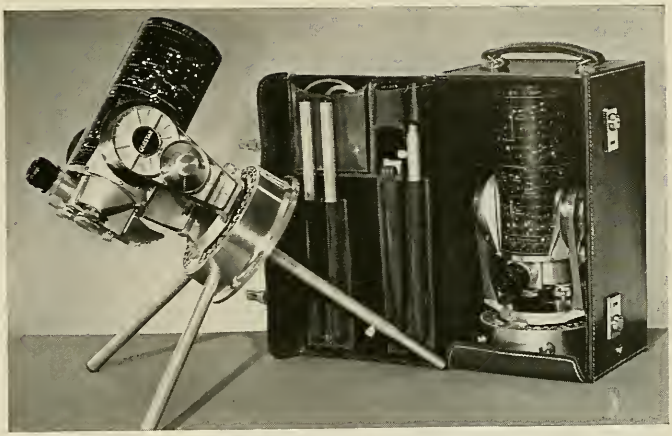
My concern with the history of flowers may come partly from experiences in Micronesia and Polynesia. Flowers on these Pacific islands play an important role in the culture. On the atoll of Ifaluk, where I spent some months, the women seemed to spend as much time tending flowers as they did cultivating taro, their basic starch. When they came in from the

ardens, along with the foodstuffs hey would bring baskets of flowers, hich were carefully woven into laborate garlands. They brought us resh garlands to wear every morning. We felt a little foolish about this t first, but soon became addicted, afixing a mirror on a post of the hiefs' clubhouse, where we lived, so hat we could be sure our flowers vere properly arranged before we allied forth for the day. I missed hose fresh flowers for my hair when came back to the United States; our ulture is unreasonably repressive of nale impulses toward ornamentation.

I remember thinking that if the eople of Ifaluk lived in the United States, they would be ardent members of the local garden club. Their nterest in flowers, however, was primarily because of their use in adornment: flowers were like beads or attooing or pieces of clothing. There eemed to be no interest in growing hem as ornamentals around the household areas, no admiration for lowers as a part of the vegetation. This may be a general attitude on the part of "primitive," or "uncivilized," nan. Anthropologists tell me that the North American Indians are not known to have cultivated any plants for their flowers; and in general I suspect that feathers and other bright objects are used as ornaments more often than flowers, although I have no statistics.

The use of flowers as garlands is not confined to the Pacific, however. Anderson notes that "In Athens Carnations and Violets were the best beloved of all flowers and were worn as garlands at weddings and other ceremonial occasions, and when the main features of the Greek culture were transplanted to Rome these flowers were included." Violets and poppy seeds were also a favorite Roman cure for headaches. This brings up the fact that many of our flowers were first cultivated for their presumed medicinal value. Lilies, for instance, appear in the early herbals because of their value in healing wounds and curing a range of internal disorders—with no mention of their appearance.

It looks to me as though general interest in ornamental gardens in the Western world started with the explorations of the sixteenth century, when travelers began bringing new plants back to Europe from all parts



of the world, and that it got a great boost from the interest in nature that developed with the French Enlightenment. Garden history in the Near and Far East, of course, is distinct and different, and many of our flowers were long cultivated there before they were brought to Europe by returning travelers. The tulip craze of the seventeenth century, for instance, was started by the discovery of this flower in a garden near Constantinople by a Viennese, O.G. de Busbecq, in 1554. By 1634, "tulipomania" had reached epidemic proportions in the Netherlands. Anderson quotes an anonymous writer to the effect that "The gaudy Tulip was an object which at one time drove the grave, the prudent and the ambitious Dutchman as wild as ever did the South Sea Bubble the gullible John Bull."

The possibility of growing ornamentals was increased immensely by the perfection of the glasshouse in the nineteenth century. I once calculated that the late Liberty Hyde Bailey, in his volume *Hortus Second*, published in 1941, which is a list of plants then in cultivation, included 19,600 species. These were perhaps mostly grown in greenhouses in the north, or outdoors in California, Florida, and Hawaii, and most of them would be captives rather than cultigens. Horticulturists ransack the world for orchids, bromeliads, and other possibly ornamental plants. The hybridization and selection of these tropical plants has become a hobby with many and a considerable business with others. We have not achieved the gambling craze of the Dutch tulip period, but we have a considerable array of special horticultural societies with journals, lectures, garden shows, and prizes.

As readers of this column know, I have a greenhouse, and I have learned a lot about plants from trying to grow them there. I have been particularly impressed by problems with seeds. I had thought that seeds were something you put in soil and left awhile for germination. But I found that with seeds collected from various rain forest plants, germination was both uncertain and haphazard. While thumbing through the journal *Evolution*, I came across an article in the issue for December, 1961, by Charles Rick and Robert Bowman, entitled "Galápagos Tomatoes and Tortoises." The authors ha[d] vainly tried to germinate seeds of [a] species of wild tomato from th[e] Galápagos Islands. Finally, they fe[d] the tomatoes to some of the gian[t] tortoises from the islands and col[]lected the seeds from the feces: afte[r] tortoise digestion, they germinate[d] fairly well. The authors then trie[d] a number of chemical experiment[s] with the seeds: they found that th[e] seeds would germinate just as wel[l] after soaking for half an hour in [a] 50 per cent solution of househol[d] Chlorox as after being digested b[y] tortoises.

I immediately tried soaking some of my tropical seeds in Chlorox—in some cases with good result, in others with continuing failure. There is, I find, a considerable literature on the chemistry of seed germination, and I intend presently to go on with experiments with tropical forest seeds. When you think of it, it is reasonable to find that seeds of wild plants germinate irregularly: if seeds of a particular species all germinated in response to a given stimulus, a climatic catastrophe could wipe out a whole generation. It is also reasonable to have germination dependent on exposure to digestion by some animal, since in that way seeds get transport to different environments.

Schwanitz, in his book on cultivated plants, cited earlier, notes "the loss of delayed germination" as one of the characteristics of plant cultigens. Other characteristics are: giantism, reduction or loss of natural means of dissemination, loss of bitter and toxic substances, loss of mechanical means of protection (thorns, for instance, and prickly fruits), simultaneous ripening of fruits, and the like. The expectation that seeds will germinate promptly and uniformly is, then, a consequence of dealing with cultigens. Seeds of our common northern wildflowers may take as long as two years to germinate or may require special treatment such as freezing.

Growing captive plants may thus be difficult. Breeding captive animals is also difficult and uncertain. Work with tropical fishes seems to me to illustrate nicely the range of problems encountered in converting a captive into a cultigen, and one of these days I want to write about the history of ornamental fish culture.

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THE NATURAL WORLD OF THE POST OFFICE

THE NATURAL WORLD OF THE POST OFFICE by Arnold Ross

The first adhesive postage was issued in 1840. In that year of her postal reforms England originated prepayment by the use of such stamps, the charge being based on the weight of a letter, not the distance it would travel. It took only fourteen years for a natural history theme to appear on a stamp. Issued by Western Australia, it was a black-and-white, one-penny stamp depicting a swan.

In those times, the responsibility for planning the themes or designs for stamps was left to professionals employed by the printing offices. By the turn of the century, however, the acceptance of designs from free-lance artists, often through competition, had become increasingly common. In any case, today's designer of a natural history stamp can draw upon many types of source material. The design may be based on a photograph, an illustration in a popular magazine or scientific journal, museum exhibits, and of course, on observations made in the field by the artist. Although many stamps accurately depict their natural history subjects, many are nothing more than stylized conceptions. For the most part, the creatures shown on the majority of stamps reflect the indigenous fauna of the country. Occasionally, however, a trip to the local zoo, aquarium, or botanical garden provides the stimulus for stamps designed around intriguing animals from faraway places. And sometimes the search for a design comes to a simple and successful end, as in the case of a stamp issued by Trinidad. It depicts a coral reef. The source of the design was not the reef itself, as the label on the stamp said, but the reef pictured in a mural hung over the bar in a local hotel.

The United States, although it issues many commemoratives, produces relatively few nature stamps. Among these, several, not surprisingly, have portrayed the American eagle, both on regular and on airmail issues. There is also the Audubon stamp showing a Colombian jay. One Christmas issue was a series of four showing plants appropriate to the season, such as holly and mistletoe. Also noteworthy is the U.S. conservation series portraying examples of indigenous wildlife.

The design of the stamp, whether based on a photograph, an old etching, or an artist's sketch, largely dictates the method of printing. Stamps today are printed by any one of several methods, and not infrequently by more than one method. These methods are lithography, engraving, and embossing. The paper on which a stamp is printed receives considerable attention because of the possibility that it will be counterfeited—although the risk here is less than with currency. Although many nations of the world today produce their own stamps, more than one half of them have their stamps designed and printed by private firms or government agencies in England or the United States. Of course, the country that contracts abroad makes the final decision in choice of designs.

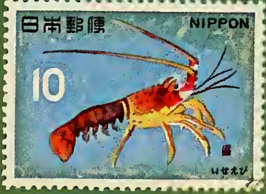
It has been mainly within the past decade that stamps portraying natural history subjects have been issued in the color and variety shown on the following pages. The primary reason for this profusion is the growing desire by new and developing nations to fill their coffers. The sale of stamps swells the treasury of many a small nation by several millions of dollars each year. It is this desire for additional revenue that has led many countries to look beyond their own geographic borders for subjects that will appeal to the collector of natural history stamps. For example, page 31 shows that Poland has put tropical reef fish on its stamps although Poland is thousands of miles from the nearest coral reef.

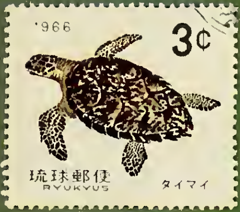
The usual collector will, of course, think of things besides the stamp's subject or intrinsic value. As with other stamps, the natural history type may have an extrinsic value resulting from a variety of causes. For instance, there may have been an error or omission in printing, the stamp may be rare, or the supply may simply be unequal to the demand. Western Australia's one-penny swan stamp, for example, is now valued at $60; some others bring prices as high as $50,000. Whatever the reason for collecting stamps, they ordinarily cost only a few cents each from a dealer and, of course, can also be obtained free in many ways.

The careful observer will see a good deal when he looks at a stamp. Besides its central theme, the name of the issuing country, and its face value in the currency of that country, the stamp will usually offer other bits of information. These may include the year issued, the printer's name, the artist's name, the common name of the organism shown, and frequently the Latinized generic and specific names. Changes in currency from one year to another may also appear on the stamp, as in the case of New Zealand, which recently changed to a decimal currency. Occasionally, stamps are overprinted with a short phrase or sentence that honors or commemorates some noteworthy event, person, or cause. Some may even be surcharged, which means altering or restating the face value. This is frequently done in lieu of issuing an entirely new stamp.

The foreign stamps shown in the following pages are but a few of the many thousands available to the naturalist, whether his interests center on flowering plants, marine or terrestrial invertebrates, minerals, or domesticated animals. Since it is believed there are few limits to the diversity of life, it should be quite apparent that there are also few limits to the subjects treated on stamps. From the collection and study of the subject matter portrayed on stamps comes a distinct realization of the complexity and uniqueness of the flora and fauna occurring in all parts of the world. The postage stamp world of nature, albeit in miniature, is obviously an open, if partly whimsical, field for naturalists.

Flora are depicted colorfully and often on the approximately 200,000 "species" of postage stamps that nations have issued so far. Wildflowers predominate but horticultural varieties, as well as fruits, vegetables, mushrooms, and trees, also serve. The stamps demonstrate that flora, like other natural subjects, are portrayed with respect for scientific accuracy. Mammals appearing here are the eye-catching types that attract visitors at zoos or museums. Likewise, they sell well to collectors, which explains why even a hyena (Mauritania) and an anteater (Venezuela) "carry the mail." The elephant, too, is chosen for impact—not as an airmail symbol.





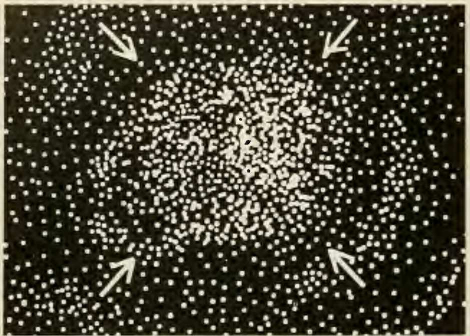
Invertebrates comprise about 94 per cent of the animal kingdom; however, only a few of the marine species appear on natural history stamps. The examples above are the file shell (Barbados), two lobsters, and a paper nautilus, or argonaut, shown with its fluted egg nest. The birds have an unrivaled distinction—they appear mainly on air-mail postage. In addition to giving some indication of how diverse bird life has become in the world, these stamps depict avian habitats, nesting sites, characteristics of flight, and even some behavioral patterns. Amphibians and reptiles first appeared upon the earth during the latter portion of the Paleozoic Era. Today, stamp collectors prize postal versions such as the ancient Brontosaurus, the behemoth seen on postage of San Marino, a tiny, self-governing country inside Italy. The dog represents man's earliest success as a domesticator of animals. Man not only tamed this carnivore but bred it to produce today's plethora of different types. Popular breeds include the boxer and the German shepherd, appearing on a Polish and Bulgarian stamp, respectively. Both are classed as working dogs.

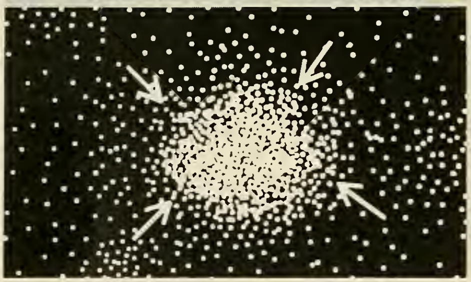
Semiprecious minerals, such as those pictured here on a series of stamps from the U.S.S.R., have long been sought as gems. The Soviet Union is mining them today principally for their usefulness in various industrial processes. Butterflies, moths, and beetles surpass all other insects in displaying color and beauty. Unique among nature stamps are those issued by Israel, in which both the insect's adult and larval forms are revealed, the latter on a tab below the stamp proper. This tab also shows the plant on which the larvae feed. The tab itself has no postal value, and may be removed if the letter's sender wants to "collect" it. Among fish faunas, few offer more variety or color patterns than reef fish, abundant in all tropical waters, and seen on five of the stamps below. The triangular one also includes a human diver. If he illustrates man's interference, so does the fish on the small Japanese stamp. It is an aquarium variety.

"WE ARE BROTHERS OF THE BOULDERS, COUSINS OF THE CLOUDS." *Harlow Shapley*
IN AN UNBROKEN SEQUENCE OF EVENTS EXTENDING OVER TEN BILLION YEARS, THE UNIVERSE EXPANDS AND COOLS, STARS ARE BORN AND DIE, THE SUN AND EARTH ARE FORMED, AND LIFE ARISES ON THE EARTH. FINALLY, MAN APPEARS ON THE SCENE.

COSMIC EVOLUTION

by Robert Jastrow





Stars are formed from clouds of hydrogen swirling through space (see Orion Nebula on page 32). Figures at left represent atoms of hydrogen, which may be brought together by the pressure of surrounding clouds. The atoms are pulled still closer together by gravity, forming a compressed pocket of gas. The heat of compression triggers nuclear reactions, which mark the birth of a star. Elements created in these reactions are sprayed into space when the star explodes at the end of its life. The sun, the earth, and the creatures on the earth were formed from fresh hydrogen enriched by the products of these reactions.

Early in the earth's history, the atoms on its surface were formed into amino acids and nucleotides, the molecular building blocks of life. The upper photo at right shows a model of amino acids linked to form a short segment of a protein molecule. Lower model represents nucleotides joined to make up a small section of the deoxyribonucleic acid molecule (DNA), the storehouse of genetic information. The DNA molecule controls the production of proteins, which in turn determine the nature of the organism. Each ball in the models represents one atom.

THE LIFE OF A STAR

Evidence uncovered in 1966 confirms that the universe began its existence 10 billion years ago as a dense, hot globule of gas, expanding rapidly outward. At that time the universe contained nothing but hydrogen. There were no stars and no planets.

When the universe was about 100 million years old, stars began to condense out of the primordial hydrogen and continued to form as the universe aged. The sun arose in this way 4.5 billion years ago, when the universe was about 5 billion years old. Many stars came into being before the sun was formed; many others formed after the sun appeared. This process continues, and through telescopes we can now see stars forming out of compressed pockets of gas in outer space.

When a star begins to form as a dense cloud, the individual atoms fall toward the center of the cloud under the force of the star's gravity; as they fall, they pick up speed, and their energy increases. The increase in energy heats the gas and raises its temperature. After this process has continued for some millions of years, the temperature reaches about 20 million degrees Fahrenheit. At this temperature the hydrogen within the star ignites and burns in a continuing series of nuclear reactions. The onset of these reactions marks the birth of the star.

Since stars live by burning hydrogen, the supply of this gas in the universe dwindles each time a new star is born. As the old stars die out, one by one, fewer and fewer new ones are formed to replace them. When the light of the last star is extinguished, life must end throughout the universe.

When a star's hydrogen is nearly used up, its life nears an end. The first sign of old age is a swelling and reddening of its outer regions. Such an aging, swollen star is called a "red giant." The sun will swell to a red giant in 5 billion years, vaporizing the earth and any creatures that may be left on its surface.

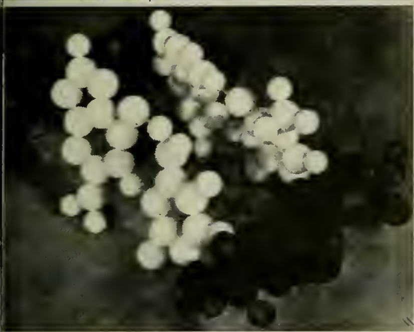
After the last of its hydrogen fuel is exhausted, a star collapses under the force of its own weight. If the star is small, it collapses gently and remains collapsed. Such a collapsed star, at its life's end, is called a "white dwarf." The sun will probably end its days in this way.

A different fate awaits a large star. Its final collapse is a cataclysmic event that generates a violent explosion, blowing its innards out to space. Dispersed into space, the materials of the exploded star mix with the primeval hydrogen of the universe. Later in the history of the galaxy, other stars are formed out of this mixture. The sun is one of these stars; it contains the debris of countless others that exploded before the sun was born.

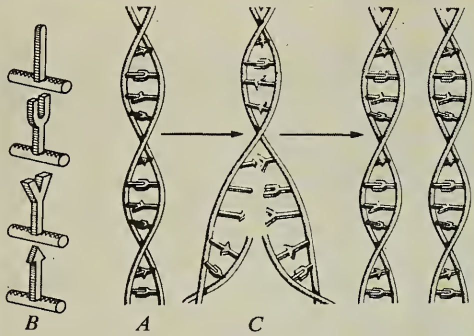
The planets also contain debris from these stars. The earth, in particular, is composed almost entirely of it. The atoms of our bodies were created in events that took place billions of years ago, in stars that lived and died long before the sun and earth existed.

ORIGIN OF THE EARTH

The earth, along with the sun, was formed 4.5 billion years ago from a parent cloud of hydrogen mixed with small amounts of other substances that were manufac-



The basic form of the DNA molecule is a "twisted ladder" (A) held together by linked pairs of nucleotides (B), symbolically shown in the model below. In the process of replication, the rungs of the ladder break at their midpoints (C), and the molecule unzips into two parallel strands, each of which then picks up nucleotides floating randomly in the fluid of living cells. In this way, identical chains of DNA are formed in each of two daughter cells, preserving the genetic characteristics of the organism.



tured in the bodies of earlier stars. The dense, hot gas at the center of this cloud gave rise to the sun. The outer regions of the cloud—cooler and less dense— gave birth to the planets, and to all living matter that now exists in the solar system.

The earth condensed out of atoms of gas to form a compact ball of rock and iron 8,000 miles in diameter. Gradually, light rocks accumulated at the surface of the young planet to form the continents. Areas between the continents were natural basins in which water, rising from the interior of the planet through volcanoes and fissures in the crust, collected to form the oceans. Slowly the earth acquired its present appearance.

DAWN OF LIFE ON EARTH

Formed out of inert atoms of gas and grains of dust, our planet was a sterile body of rock at the beginning. The waters of the primitive oceans were devoid of life; their waves lapped at barren shores uncarpeted by vegetation. Yet today, plants grow everywhere; the continents crawl with a million varieties of animal life; 20,000 kinds of fishes inhabit the seas. How and when did this rich variety of living forms appear?

Biologists have discovered that all living organisms on the face of the earth depend on two kinds of molecules—amino acids and nucleotides, which are the basic building blocks of life—just as the physicists have shown that all matter in the universe is constructed out of three building blocks—the neutron, the proton, and the electron. Chemists have manufactured these molecular building blocks of life in the laboratory out of simple chemicals, under conditions resembling those that existed on the earth when it was a young planet. These recent discoveries lead, for the first time, to the conclusion that life on earth developed from such molecules in the early years of the planet's history.

The earliest forms of life—bacteria and simple plants—are found in rocks about 3 billion years old. At that time, the earth was approximately 1.5 billion years old. Apparently then, a billion years or so was the time required for life to arise.

One billion years ago, worms appeared, and 400 million years later, according to the fossil record, life exploded into a profusion of different forms. Four hundred million years ago, in a time of drought, the first fishes waddled out of stagnant ponds onto the land and from these descended the reptiles. About 200 million years later, branches of the reptile family gave rise to the dinosaurs, birds, and mammals.

EMERGENCE OF MAMMALS

The dinosaurs flourished for 130 million years. During this long interval mammals remained in a subordinate position—small, furry, mouse-sized animals, inconspicuous, keeping out of sight of the rapacious dinosaurs. Then, 70 million years ago, the dinosaurs suddenly disappeared, probably because the climate took a turn for the worse, and cold-blooded dinosaurs could not survive the change. At that point the mammals—warm-blooded, and adaptable to changes of climate—came down from the trees and up from their burrows, and inherited the earth. Quickly, they adapted to new

opportunities and new sources of food. Within 20 million years, the ancestors of the bat, the whale, the lion, and every other animal familiar today had appeared.

INTELLIGENCE DEVELOPS

Some of the primitive mammals remained in the trees. These tree-dwelling mammals needed three characteristics for survival: grasping hands to hold on to branches; sharp, binocular vision to judge distances to nearby branches; and centers of the brain for the co-ordination of sight and touch. Tree-dwelling animals with these characteristics flourished. Those without them "fell from the trees," and left no survivors. In this way, under the pruning action of natural selection, eyes and hands improved steadily.

Animals with hands, good eyes, and co-ordination of sight and touch could make and use tools. For those with this ability it was valuable, in the struggle for survival, to be able to remember the use of tools in the past, and to plan their use in the future. The creature with good memory, and with the ability to plan, possessed an advantage over its neighbors, and was more likely to survive and leave progeny. The progeny inherited these desirable mental traits. Thus, the centers of the brain in which past experiences were stored, and future actions were contemplated, expanded. The brain con-

tinued to expand under the pressure of the struggle for existence. It doubled in size in its first 10 million years, and doubled again in the next million. Thus was the line of ascent leading to man firmly established.

THE BRIEF HISTORY OF MODERN MAN

Fossil evidence suggests that the line of evolution leading to modern man branched off from the main stem of primate evolution between 10 and 20 million years ago. Modern man appeared approximately 100,000 years ago. These times are very brief in comparison with the age of the earth.

An analogy will help us to appreciate the briefness. Shrink the 4.5-billion-year lifetime of the solar system to one year; then, starting on January 1:

1. The sun and the planets formed in the first 10 days.
2. Life appeared in the spring.
3. Worms and other soft-bodied animals arose in the fall.
4. Fishes appeared at the end of November and walked out onto the land in the first days of December.
5. Dinosaurs arose December 10, and disappeared a week later.
6. Man's ancestors branched off from the main stem of evolution two days before the end of the year.
7. Modern man appeared 15 minutes before midnight on December 31.

THE CHANCE OF EXTRATERRESTRIAL LIFE

For a variety of reasons, it is doubtful that life exists on most planets in our solar system. However, life is possible on Mars. The planet is cold and dry, but it has a trace of moisture, and simple, hardy plants may have evolved.

Life may also exist on Jupiter, because its atmosphere contains the very gases out of which biochemists have created the building blocks of life on the earth. However, life on Jupiter would be very different from the life we know.

In our Galaxy alone, there are 100 billion stars. Probably many have planets. Perhaps only one planet in a million resembles the earth, but that would still amount to 100,000 earthlike planets in our Galaxy. Moreover, there are 10 billion other galaxies within range of the largest telescopes. That adds up to a vast number of planets.

It may be that all, or nearly all, of these planets are barren bodies of rock. However, if life appeared spontaneously on the earth, it could appear elsewhere. One means of estimating the likelihood of this lies in the exploration of Mars. Mars—very dry and cold—is less favorable than the earth for the support of life. But if life has evolved in the forbidding climate of Mars, the chances are quite good that it has arisen elsewhere. If life does not exist on Mars, the question remains open.

NASA will undertake the search for Martian life within ten years if it can be done with instruments, and perhaps in twenty years if a manned landing is required. The detection of life on Mars would be the most important discovery of the space program in pure science.

CONTACT WITH OTHER INTELLIGENT SOCIETIES

That the earth was formed when our Galaxy had already existed for 5 billion years indicates that many stars in our Galaxy are billions of years older than the sun and many are billions of years younger. Earthlike planets circle around many of these stars; on some of these planets, intelligent life may have evolved.

On the earth, the passage of 1,000 years has produced enormous changes in scientific knowledge. Yet, 1,000 years is the blink of an eye in the lifetime of a planet or star. The changes that can occur in a billion years are beyond our imagination. Remember that a billion years ago, according to the fossil record, man's ances-

About ten thousand of the 100 billion stars in our Galaxy are represented in the photograph at left. Most galaxies, including our own, have been flattened by spinning action, and have a form similar to the one viewed edge-on in the photo below. In total, 10 billion known galaxies are scattered throughout the universe.

tor resembled a worm. Some extraterrestrial societies, existing on planets younger than the earth, would be extremely primitive in comparison with ours; but others, with an earlier start, could have surpassed our achievements long ago. They may have reached great heights of wisdom or great heights of scientific knowledge, or both.

Assuming that intelligent life has developed elsewhere, it is to the planets surrounding stars older than the sun, containing societies more advanced than ours, that we should direct our attention, for we can expect that these advanced societies will have mastered the techniques of radio communication and harnessed the power required for transmitting signals over vast distances with a greater skill than we can hope to achieve in this century. Just as Columbus discovered the Indians, rather than vice versa, we must expect that the advanced societies will contact us before we reach them.

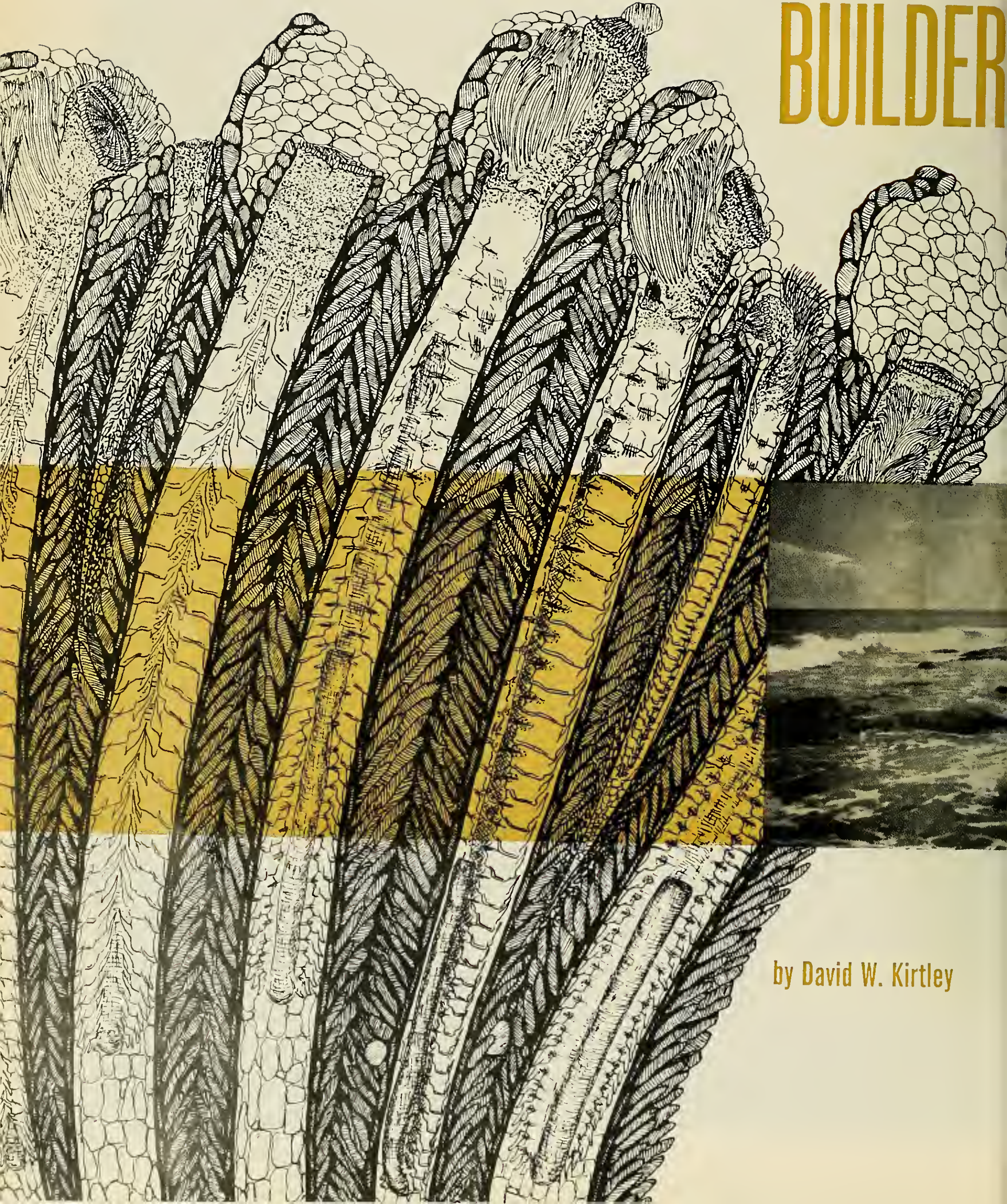
Regrettably, physical contact with societies on planets circling other stars is an unlikely prospect in the foreseeable future, for the average distance between stars is 30 trillion miles. It would take a spacecraft moving at rocket speeds about 100,000 years to cover this distance.

However, interstellar communication is possible. The threshold of radio communication, which we crossed 60 years ago, surely has been crossed on other planets thousands, if not millions, of years ago. We must expect that others, with capabilities for radio communication far in advance of ours, are already listening, and will hear us first. However, it is still too early for us to expect to receive a message from these intelligent societies if they exist. On the scale of stellar distances, the earth is an inconspicuous speck of dust circling an undistinguished star, one among 100 billion similar stars in our Galaxy. It would be a hopeless task for any intelligent society to systematically explore every star in its neighborhood in the search for inhabited planets. We must make ourselves conspicuous; we must make it clear that intelligent beings live on this planet—by beaming radio signals or in other ways—and only then will anyone bother to look in this direction.

Contact can occur when we are able to harness the energies required for sending radio signals over interstellar distances, when we have refined techniques for detecting weak signals sent in reply, and when we have sufficient curiosity in the outcome to warrant the necessary expenditures. It is unlikely that we will reach this state in our lifetime; we may reach it in the lifetimes of our children or grandchildren.

The apelike creature that was man's forebear evolved from small mammals, similar to the tree-dwelling tarsier (right). These mammals had grasping hands and binocular vision, originally adaptations for an arboreal existence. Only animals with these two requisites had the potential to use tools. As evolution proceeded, the capacities to remember the past and to plan for the future—distinguishing features of human intelligence—were developed, giving substantial impetus to tool use.

THE REE
BUILDER



by David W. Kirtley

It is a relatively calm day along this Florida beach, and the Atlantic Ocean's ebbing tide has already exposed a wide expanse of sand. Let us stand very still and watch closely for a few moments. This may give us a better idea of what is happening.

First comes an awareness of rhythm. Back and forth, the water's edge recedes and advances across the low-angle face of the beach. Back and forth, the comic sandpipers flock over the sand, following when the water retreats, then turning to outrun the next wave.

There are also the details that a tidewater oceanologist would notice. Behind each receding wave the sandpipers busily poke their beaks into the wetted sand to devour the tiny organisms that burrow there. The waves are at work too. While surging in over the tidal area the water becomes turbid with the fine, loose sedimentary material scoured from the bottom and carried toward shore. Meanwhile, the corner of the eye catches signs of ghost crabs (*Ocypode albicans*) scurrying over the rotting, drying seaweed that the retreating tide abandoned in neat rows along upper reaches of the beach.

Very different from coral, these wave-washed reefs are the stonemasonry of small, persistent worms. Drawing shows sabellariid colony (Phragmatopoma lapidosa), *mostly adults within their cylindrical, meticulously constructed homes. Nearest tube: Creature is fully withdrawn to escape predators. Center tube: The head (opercular stalk) is fully extended so its many tentacles can collect food, and also the sand particles with which to build higher. "Teeth" at very top hold an already cemented particle that the head will implant at chosen spot along tube wall.*

But not everything here is movement. Scattered on the beach are what seem at first to be lumps of sandy material. On inspection, one of them, about the size of a man's fist, turns out to be a bundle of cylindrical compartments that were glued together somehow—a colony of tubes that probably broke off a larger piece. The inside diameter of each tube is somewhat thinner than a lead pencil, and the tube is empty now. But apparently it did have an occupant. How else explain the symmetry with which the tiny pieces were meticulously assembled to form each slightly tapering cylinder? The building materials—mostly sand particles—were certainly available enough. The builder could have picked them right out of suspension in the surging coastal waters. And a colony of animals could account for such an aggregation of tubes.

Its color is drab, hardly that of coral. But did it break off from a reef of some kind other than coral? Down below the beach face, where the tide is still retreating, some low, rounded mounds of a dark-brown material have been rising from the shallows. As we wade out to inspect one of them we become aware that its surface shows a honeycomb pattern. Again we think of a reef.

When we step upon the mound, it seems to yield a bit, but doesn't collapse. Looking down, we notice that each of the honeycomb's compartments is darker toward its center. And when we bend down—sudden commotion! The dark center had actually been the front tip of a wormlike animal. Each creature had flashed backward, lower into its tube-shaped private gallery. Down through the hoodlike aperture, the top of its head is still visible.

It pays to stand very still. A moment later, each animal extends tiny tentacles back through the orifice of its tube. Then, right before our eyes, the creatures resume normal activities, feeding and building. When a wave breaks over the reef, their tentacles reach out to collect food and construction materials from the water. These they seize with special grasping "teeth" and implant in the tube wall with help from the stout opercular stalk that serves as the animal's head. In this way, by adding on, the already elongate compartments are made still longer.

We break off a piece of the honeycomb rock and confirm the already obvious. This is the same material we found back on the beach, but now each tube is occupied by a small, segmented, dark-headed animal—the reef-building sea worm known formally as *Phragmatopoma lapidosa*.

The group of tubes is so friable that it can be broken by hand. But up and down the surf zone we can see the reefs alternately covered and exposed as each wave breaks over them—yet they have been engineered well enough to dissipate the pounding. And the tube worms, with bodies seldom as much as two inches long, have also done their work well enough to account for the helplessness of a freighter that we see very near shore. Many months ago, the *Amaryllis* was driven landward during a hurricane. She came to rest on the landward side of a worm reef, and is still there—one of a succession of vessels, dating back to treasure-laden Spanish galleons, that have come to grief on such reefs.

Such are the marine worms of the family Sabellariidae, and the reefs they build. Although at first glance these might be mistaken for the work of organ-pipe corals, they are very unlike the better known coral reefs. The latter owe part of their glamour to the fact that they are often brightly colored. But this is not the main difference. Corals are calcareous, built by polyps that secrete the calcium carbonate that becomes the cups in which they live; the sabellariids act more like stonemasons—they select already formed granular particles out of the water and secrete only the substance needed to cement them together. Oddly enough, most mari-

ners think sabellariid reefs are merely dead coral reefs.

What are the tube worms really like? Just how do they perform their masonry, and how does it affect the seashore?

They are distributed as many species in many parts of the world. For example, they were first described scientifically from the coast of France by the naturalist Réaumur, in 1711. He called them *Vers a Tuyau* ("tube worms"). This article concerns mainly the three species that I have observed in Florida and elsewhere during the past three years. *Sabellaria floridensis* is common on Florida's Gulf Coast and has also been reported from Florida's Atlantic coast, near Marineland. *Sabellaria vulgaris* is found at least as far south as Daytona Beach, and reportedly lives as far north as Cape Cod, Massachusetts. *Phragmatopoma lapidosa*, which I have already mentioned, seems the most efficient reef builder of the three. This sea worm commonly constructs wave-resistant reefs of impressive size in bands nearly parallel to the shoreline. Although formally classed as belonging to a different genus, and distinguished by such features as its larger size and darker color, the structure and habits of *P. lapidosa* are much like those of the other two species.

Anatomically, the Sabellariidae share several important features. A dark, stout head is equipped with two rows of ciliated feeding tentacles along its underside. The head carries a coronal array of hard, toothlike grasping organs and a ring of paddle-shaped setae that dress the "mortar" during construction and seal the end of the tube when the animal withdraws. Below the feeding tentacles is the mouth, with its pair of palpi that serve as small sensory and manipulative tentacles.

Farther down are the three segments of the parathorax, with padlike bundles of setae on either side; then about 35 abdominal segments with their tiny uncini (hooks) that anchor the body to the surrounding tube wall. Finally comes the cylindrical tail.

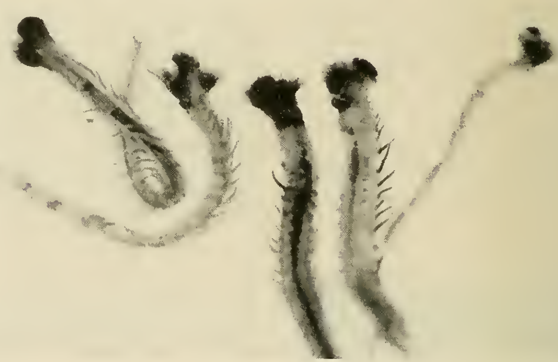
The sexes are separate. The female body is readily distinguished by its lavender or pale-pink color, which comes from the eggs contained in each segment of the body. In males the corresponding color, whitish gray, comes from sperm contained in the gonads of each body segment.

At the shore we can break off a portion of reef and place it in a bucket of sea water to watch the worms discharge clouds of eggs and sperm. For laboratory observation, the worms can be placed in a shallow dish of sea water and there, aided by the microscope, we can see what occurs after fertilization. After seven to twelve hours the embryos develop into the free-swimming trochophore stage, in which the larvae resemble minuscule spinning tops. Later they develop the long natatory bristles with which they can defend themselves when irritated or alarmed.

What happens afterward is described by British zoologist D. P. Wilson, who carefully followed the larval growth stages of *Sabellaria alveolata*, an abundant European species similar to those in United States waters. After fertilization, larvae reared in his laboratory required from six weeks to three months before they were ready to metamorphose to the final, settling stage and begin building their sand tubes. In areas where ocean currents are strong, this would give time enough for larvae to be moved far from their birthplace—to expand existing reefs and start new ones. On their journey, they would be a copious supply of planktonic food for larger sea life of the oceanic waterways.

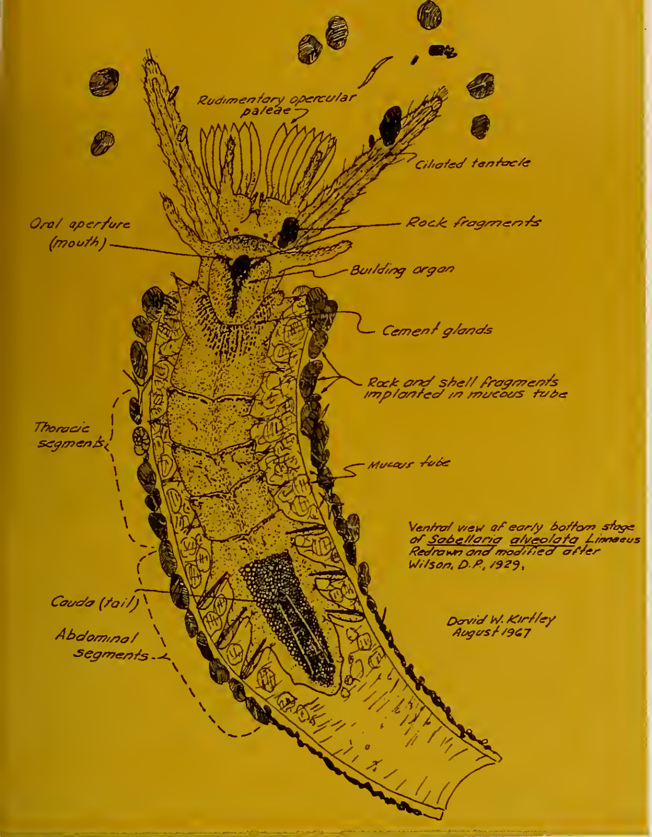
At the time of their settling stage the young larvae have eyespots on both ends of the body. Presumably, with these simple visual organs they look about for a good attachment site. The choice is important, because once the sabellariid starts building, it has little opportunity to change its mind.

Below: Adult worms look like this when removed from tubes. Right: Though its head is undeveloped, a 7-week-old juvenile can use its few tentacles to move the rock fragments needed to reinforce its weak encasing tube.



The first portion built is a small, transparent mucous cylinder, about two millimeters long—just enough to encase the tiny creature. At this stage, the prehensile tentacles above and to either side of the mouth are large compared to the rest of the body; with them the worm collects small fragments of minerals, diatom frustules, sponge spicules, and other small objects of manageable size. It implants these reinforcements in the delicate mucous tube.

During this crucial period, if the worm is broken loose from its attachment site with a portion of its tube intact (and if a reef fish doesn't devour the worm forthwith), it could possibly repair the tube quickly and get a second start. But this is unlikely in nature because the reefs usually teem with predators. So only the larvae and juveniles that attach themselves to a favorable site, rapidly develop their protecting tube, and quickly set up housekeeping can be



available, larger fragments of shell and larger grains of quartz are preferred for the terminal. Some species add a circular collar inside the hood: the worm withdraws its head through this collar, which then helps seal in the sea water needed for survival when a dropping tide exposes the tube to the air or when the worm is waiting for a predator to depart.

But precisely how does the worm do its building? It literally uses its head. The opercular stalk and the teeth at its crown—the clawlike paleae—do much of the work.

From time to time one can see the worm extend the first few segments of its body out beyond the tube. It is reaching for particles of sand and crushed shell brought by the scouring waves. The teeth atop the opercular stalk, which bends easily, grasp them and pass them down toward the mouth with the help of the feeding tentacles. At the mouth the stony fragment is "licked" clean of encrusting plants and other tasty organisms. Then, if the piece is of a size, shape, and consistency that suit the worm, it is coated with a pelletized mucous cement. (This is produced in glands located in the parathoracic segments and secreted through the "building organ," just beneath the mouth.)

Next, the sabellariid adds the proper concentration of a "fixative" substance. This will harden the cement to a dark-brown, leathery consistency. (The same cement is also used for lining the entire interior of the tube.)

When wedging is necessary, the worm first uses its opercular teeth to position the rock fragment. Then it retracts the teeth into the shape of a flattened crown. Finally, it drives the new fragment into the tube structure with hammer-like blows from the upper part of its head.

Farther down, the setae pads on either side of each parathoracic segment contain five to eight distally flattened paleae, each with a paired, slightly bent acicular spine. These organs are used in locomotion; they also help dress the cement and maintain the internal shape of the tube. Bundles of setae located on the ventral side of each body segment help with locomotion as well as removing

counted on to survive and continue the rest of their life cycle.

At first, the reinforcing pieces of rock are not arranged well, and the choice of fine particles shows little specificity except that they are of uniformly small size. But as the worm grows, and the prehensile teeth of its corona become better developed, it can be more choosy about the types of building materials it selects from the turbulent waters. Also, thanks to the strong teeth and dorsolateral muscles on its opercular stalk, it can now seize and manipulate larger pieces of rock.

Generally, after the initial tube is completed the worms begin incorporating more of the small, but relatively heavy, mineral grains—such as epidote, clinozoisite, staurolite, and ilmenite-magnetite. This selectivity concentrates heavy minerals in the reefs. Analysis shows the reefs accumulate as much as ten times the amounts found in nearby surrounding sediments of the foreshore and in the landward beach sands.

Later in their tube building the worms choose among a greater variety of materials. Into upper parts of the cylinder are set angular quartz grains, small fragments of broken mollusk shells, foraminifera tests, ostracod carapaces, echinoid spines, fecal pellets, and other materials—all arranged in an overlapping spiral pattern that rises to the base of the flaring aperture. It is the grouping of these terminal apertures that gives the reef its honeycomb appearance.

When mature, the upper part of the worm is within an encircling tube that has an internal diameter of between three and four millimeters. The outside diameter will vary for several reasons, including the amount of crowding. At the bell-shaped terminal the outside diameter becomes eight to ten millimeters. Flat, platelike fragments are used to line the inside wall of the tube. When

the metabolic wastes from the tube.

When feeding, the worms normally lie on their dorsal sides with their ciliated feeding tentacles extended upward and outward, almost completely filling the hooded aperture. The beating by the myriad cilia and the peristaltic motion of the body segments produce a rapid circulation of sea water past the tentacles, the mouth, and throughout the tube. In this way, food materials are periodically ingested. Marine algae, diatoms, foraminifera, and other small marine organisms serve as food.

The sabellariids are so familiar along the nearshore floors of Europe's coasts that they have acquired common names, such as "ross" by English sailors; *crassiers* (mounds, or heaps) in France; *Pumpwürmer* (pump worms) and *Austerntod* (oyster-killer) in Germany; and *tremolina* (trembling) on the Latium coast of Italy. All told, they are easily found on seashores around the world from as far north as Point Barrow, Alaska, to as far south as the Falkland Islands in the South Atlantic.

Such a wide distribution in modern seas, as well as the fact that these reef builders have been traced back as far as Carboniferous times, strongly suggests that they have done much to change seashores in the geologic past. Wherever they have found an abundance of tube-building materials, turbulent waters to promote reef growth, and other favorable ecological conditions, the sabellariids probably have played an important role in the accumulation of some sedimentary rocks and have helped change coastlines of ancient seas.

Although a long-term, detailed study of the growth rates and lifespan of *Phragmatopoma lapidosa* has not been made, its colonies have been seen to settle on rubblestone groins and in six weeks build encrustations ten inches or so thick around the base of the boulders. An observer in Germany offers this figure: he measured the growth rate of a *Sabellaria alveolata* reef and found it to be between 1,000 and 1,300 cubic yards in six months.

The worms can also be speedy when they repair tubes that have been damaged. For instance, when fishermen and bathers walk over a *P. lapidosa* reef, their footprints show where they have crushed the delicate, hooded apertures. But when revisited the next day, the reef is found without footprints—as sound as it was previously.

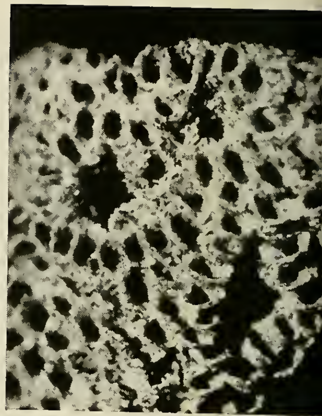
How do the reefs stand up to worse punishment? Much depends on where the worms attach themselves. In Florida's intertidal zone it is unlikely that their construction attempts up along the legs of new fishing piers will remain indefinitely. In contrast, there is a very durable reef formed around the base of a pier built behind the famous Breakers Hotel at Palm Beach. This pier was long ago destroyed by fire and storm, but the reef around its base can still be seen from the air—a long rectangular mass that is at right angles to the normal, alongshore direction of reef development.

The durability of this sea worm's product—and home—is best witnessed along Florida coastlines during the hurricane season, in late summer and fall. It is then that the tube builder's engineering competence is severely tested. It is a time when ocean waves are extremely turbulent, when boiling waters toy with natural beach materials—and, often, with man-made structures too.

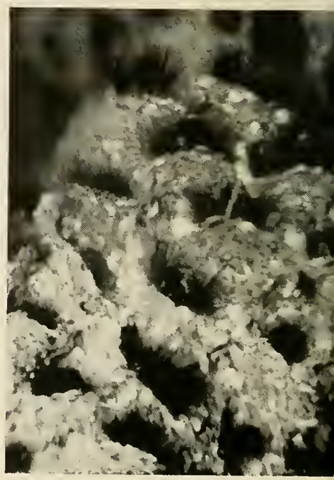
Huge slabs of beach rock, some of them fifty feet long and twenty feet wide, can be seen rafted about in the waves; powerful breakers cut deeply into protective sand dune ridges and onto roadways bordering the ocean front; driving winds blow wet sand landward off the beaches and onto the dune fields. After calmer seas return, one finds that profound, if temporary, changes have come to the shoreline. Beaches are excavated landward, roots of the dune vegetation are exposed. Sand from the beaches has been spread out beneath the foreshore water and may temporarily cover portions of the reefs.

And the reefs themselves? They have hardly changed through all the pounding and surging.

It is therefore not hard to understand why the extensive sabellariid reefs along the lower east coast of Florida have in historical times brought much woe to mariners. Navigation charts of the nearshore area are dotted with the locations



Above: The flared terminals of sabellariid tubes give reef surface a honeycomb appearance. Below: Closer, looking through magnifying glass, one easily sees tentacles emerging when the worms resume feeding and building. Author's semischematic diagram of a stretch of Florida shoreline illustrates how reef worms aid conservation. To begin with, sand is impounded by the worms as reef material. Later, sponges change old worm tubes of seaward reefs into durable rock. Waves breaking over them leave sand and shell hash in quieter area landward, where some of the material eventually consolidates to become beach rock.



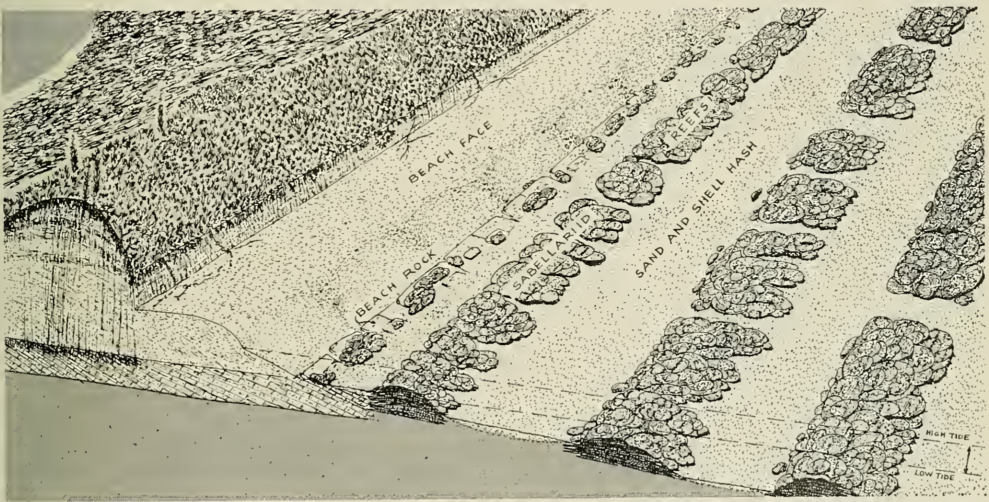
of known wrecks—some dating back to the Spanish Conquest—that were probably quickly covered by encrusting *Phragmatopoma* and remain buried. For instance, in 1696 the famous *Reformation* was wrecked on the worm reefs just north of Jupiter Inlet on the Atlantic coast. As a result, Jonathan Dickinson and twenty-four other survivors spent a terrifying month and a half on land among hostile Indians. Another result was Dickinson's famous journal, *God's Protecting Providence*, which became a literary and historical classic.

diving or to dredging from a boat.

The reefs along the open coast are not the only navigational hazard designed by the sabellariids. There is also danger in the artificial narrow inlets of harbors and in the natural gaps between the barrier islands on the Florida coasts.

To begin with, the diurnal flushing of the tidal currents provides abundant sand and nutriment for the worms. Consequently, they grow efficiently on concrete bulkheads and rubblestone jetties, and "pave" the bottoms of the channels. Growing onward and upward, their colonies of worm's tube. This ecological community also includes the sponge. One of its species, *Cliona lampa*, is especially adept at boring through the depopulated masses of tubes, extracting silica for its own needs, precipitating calcium carbonate, and thereby reconstituting the original building material so that the result is solid, durable rock.

Nor is this all. As waves breaking over the reefs lose their energy in a cloud of spray, they impound a buildup of shell fragments, sand, and other materials in quieter water on the landward side. Through consoli-



Today, ships are still driven landward during hurricanes and founder on the dense worm reefs waiting just beneath the sea's surface. The *Amaryllis*, mentioned earlier, is only one example.

There is plenty of opportunity for such trouble. The reefs are widespread, and some are large indeed. I found one reef system, off the Florida coast, that was eight miles long and, in some places, two miles wide. The best way to see the reefs is from the air. In this fashion I have spotted the ones farther out from the beaches at depths as much as eighty feet below the ocean surface. For a more detailed inspection of the reefs I sometimes resort to skin tubes at times threaten to choke off the navigable channels and permit the passage of only shallow-draft boats. To keep the channels free requires recurrent, expensive dredging. Meanwhile, narrowed channels increase the velocity of the tidal flushing. This makes navigation quite dangerous during the running tides.

But ecology is not a simple science. With the troubles they cause, the sabellariids offer some benefits. A reason for the conservationist's interest in their reefs is that they provide ideal homes for the spiny lobster. This lobster feeds on the snail *Thais*, one of the predators that devours sabellariids. It does so by thrusting its proboscis down the dation some of this eventually becomes beach rock. I believe that the large slabs of fossil coquina used by the Spaniards who built the Castillo de San Marcos at St. Augustine might have come from rocks formed in similar fashion.

The troubles and benefits brought by the myriads of busy sabellariids are still not understood well enough by designers of coastal defenses and inlets. We also need more knowledge about the long-term effect of the reef builders upon projects designed to control and remedy beach erosion. It is likely that with more knowledge we will be able to build more successful sea walls, groins, jetties, piers, and the like.

SKY REPORTER

Cloud-shrouded Venus, shining brightly in the east before sunrise this month, clings to her secrets protected by a "hellhole" atmosphere hot enough to melt the electronic bugging devices sent there by man.

American and Soviet probes, which reached our neighboring planet in October, revealed surface temperatures of about 500 degrees and an atmosphere so dense that light waves may be refracted enough to completely circle the planet, enabling a very hypothetical observer on Venus to see the back of his head in front of him.

Data sent back across 50 million miles of space show that the planet has a weak magnetic field, that it has no radiation belts similar to those around the earth, that the dark side of the planet emits a faint ultraviolet glow, and that the atmosphere of Venus is 75 to 85 per cent carbon dioxide. The abundance of CO_2 and the lack of water are leading investigators to conclude—sometimes reluctantly—that the clouds that always cover the planet's surface are made of dust rather than water or ice particles.

Like any good scientific experiment, the Venus probes have raised new questions while answering a few of the old. But with confirmation of temperatures too hot for electronic devices, much less for people, and with the increasing reluctance of Congress to spend money for space exploration, the data sent back by Mariner 5 and Venus 4 may be the last close-up information we will have for years to come.

A BIRTHDAY

The Association of Lunar and Planetary Observers (ALPO), an American amateur group, celebrated its twentieth anniversary in the latest issue of its journal, *The Strolling Astronomer.*

While some writers in the anniversary issue seem ready to turn in their telescopes in the face of a manned lunar landing and probes to other planets, it is significant that in the same issue there is an appeal from a NASA scientist for naked-eye observations of the lunar libration clouds ("Sky Reporter," August-September, 1967) so that they can be more accurately charted. This is the latest of several requests from the professionals in the last several years.

Walter H. Haas, Director of ALPO since he helped form it in 1947, says that in the future he expects the association to take on more projects with very specific goals and limited periods of duration. It is perhaps no coincidence that in the same issue an astronomer at the University of Arizona asks for as many observations as possible of the lunar crater "Ross D" on five different dates. The times at which the observations should be made are specified to the minute. Simultaneous observations increase the likelihood of any real phenomenon being confirmed by two or more observers.

ALPO is in the process of publishing an observing handbook, which it hopes will encourage more amateurs to make better and more useful observations. The book is being published in the belief that amateurs will be out in the backyard on clear nights for some time to come.

John P. Wiley, Jr.

CELESTIAL EVENTS

During the early evenings in January, the winter stars and constellations are visible in the east, rising as darkness comes on, spending the whole night crossing the sky from east to west. There are no planets crossing, but two—Mars and Saturn—can be seen in the west shortly after sundown. Mars is quite low when it becomes visible, near the crescent moon on the evenings of January 2 and 3. Saturn is easier to find, high toward the southwest among the faint stars of Pisces. The vernal equinox—the point in the sky where the sun is located on the first day of spring—is only a few degrees to the right of Saturn's position.

By a few hours before midnight, the constellation Orion has moved to the south, where it is highest during the night. Saturn is then setting in the west, and Jupiter rising in the east, brilliant among the stars of Leo. In the hours before dawn, Jupiter moves past the meridian and Venus can then be seen in the southeast, rather low, but brighter than Jupiter.

Before Venus fades into the dawn, look for the reddish star Antares, well to the right of Venus, in the constellation Scorpio. On the 25th, at about 6:00 A.M. EST, the moon will pass between the earth and Antares for observers in North America, Europe, and North Africa. The occultation of Antares by the moon will be the first of twelve occultations of the star during 1968.

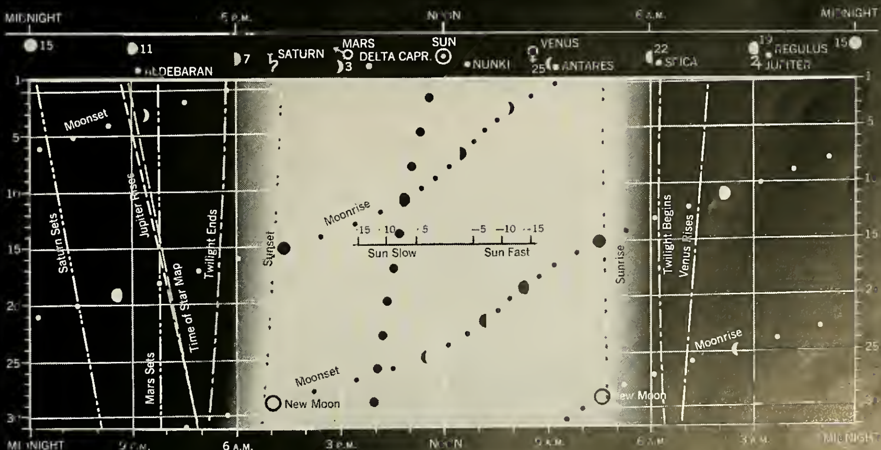
Mercury comes into the evening sky this month, attaining its greatest distance to the left of the sun. On the evening of January 30 this planet sets more than an hour and a half after the sun—a favorable evening elongation of the planet. Mercury will be the bright object (magnitude—0.5) to the right and above the crescent moon on the evening of the 30th, and well to the right of the moon on the 31st.

The expected maximum of the Quadrantid meteor shower is on January 3, when there will be no moon to interfere with early morning observations. This shower lasts only about half a day and produces up to about 40 meteors per hour.

Thomas D. Nicholson

Hold the star map so the compass direction you face is at the bottom; then match the lower stars with those in the sky near the horizon. The celestial events chart shows times of rising and setting of the sun, moon, and principal planets; times of twilight; and sundial correction during the month. The horizontal scale shows time; vertical scale shows dates. The top strip locates bright stars, planets, and the moon within the zodiac. The horizontal scale of hours shows the time when planets and certain stars are due south and highest at midmonth. The different phases of the moon shown are due south and highest on the dates indicated.


N
S
E
W
LITTLE DIPPER
BIG DIPPER
URSA MAJOR
CEPHEUS
CAMELOPARDALIS
LYNX
LEO
GEMINI
TAURUS
PLEIADES
PERSEUS
PEGASUS
PISCES
ARIES
ORION
CETUS
ERIDANUS
LEPUS
CANIS MAJOR
Sirius


MIDNIGHT
6 P.M.
NOON
6 A.M.
MIDNIGHT
15
11
ALDEBARAN
7
SATURN
MARS
3
DELTA CAPR.
SUN
NUNKI
VENUS
25
ANTARES
22
SPICA
19
REGULUS
15
JUPITER
Moonset
Saturn Sets
Jupiter Rises
Mars Sets
Time of Star Map
Twilight Ends
Sunset
Moonrise
15 10 5
5 10 15
Sun Slow
Sun Fast
Moonset
New Moon
Sunrise
New Moon
Twilight Begins
Venus Rises
Moonrise
6 A.M.
3 P.M.
NOON
MIDNIGHT

DEATH IN CHAMULA

by Patrick Menget photographs by Mathias T. Oppersdorff

"God in the sky, Lord Jesus, Father San Salvador, Father San Manuel, Father Saviour,
Your own face disappeared, Your own sight disappeared,
How are we going to hide his head, how are we going to hide his bones,
We, your children, your younglings,
He is to be buried in the earth, he is to be buried in the mud,
Lord Jesus, Father San Salvador, Father San Manuel,
Let us know more, let us know the prayer, Your words, Your speech, Lord Jesus."

The voice of the old man droned on in the damp evening. He staggered away from the fresh moist clay of the open grave and turned to the small group of relatives and neighbors—all male—who had listened intently to his chant. A younger man stepped forward and pulled a bottle of white rum and a stained shot glass out of his ragged poncho. Slowly bowing to the reciter, he muttered a few indistinct words and then extended a full glass of liquor to the elder, who addressed a ritual toast, in turn, to each of the men standing by, from the oldest to the youngest. "I take it" said the old man. "Drink it" answered the younger ones. After the last exchange the elder gulped down the liquor, spat on the ground, and made a wry face—as one should to show that the liquor is nice and strong—then passed the glass to the next man in line. While the men were ceremoniously and gloomily emptying the bottle, the women stood silently a short distance away from the row of graves. A black cluster of weary and sad faces, huddling their children in the folds of their black shawls, they stared blankly at their husbands and relatives.

It had been a long, painful walk uphill, behind the men who stumbled on the muddy path under the weight of the casket. The rain made the children restive and unhappy, but the men had drunk too much to care. Now the men had finished the last bottle of liquor. A couple of boys quickly filled up the grave with earth and trampled it under their feet. They washed their hands with water from a bucket they had carried uphill to the graveyard, as did all the

Simple, stark, and powerful, beset with flowers,
pine boughs, and branches of laurel, towering timber crosses
dominate the San Sebastian graveyard at Chamula
during the fiesta of Todos Santos.
Equivalent to All Saints' Day, this is when certain
of the departed—those who died from natural causes and
who left at least a modest inheritance—
return to earth to visit friends and relatives.
The church bells toll throughout the day and professional musicians,
virtually ubiquitous in the presence or formal recollection
of the dead, stride among the celebrants
strumming their plaintive, repetitious dirge, the bolomchon.

men. It would be dark before everyone was back home. The green valley had already turned gray and misty.

This burial took place one summer not long ago in the hills of central Chiapas, Mexico. The rugged mountains of the state of Chiapas were the last part of southern Mexico to open up to modern civilization, for not until the 1940's did the Pan-American highway connect the region of the Isthmus of Tehuantepec to San Cristobal and even farther to the Guatemalan border. As you drive along the highway you can see groups of brightly clad Indians and clusters of thatch-roofed huts among the cornfields. The region is inhabited by more than 150,000 Maya Indians. They speak either Tzotzil or Tzeltal, languages closely related to the ancient Maya of southern Mexico and Guatemala. But unlike the ancient Maya, who built the palaces and temples and erected the enigmatic and majestic stelae scattered in the jungle, the Indians of Chiapas do not have a writing system of their own. They use Spanish for their records and for all communications with the Mexican central government. They live in self-administered communities, each with its own dialect and customs. Chamula, the largest of those communities, with upward of 40.000 people, is to a great extent the most resistant to Mexican acculturation.

The Chamula are corn farmers, like all the Indians in the state of Chiapas, but their land is not overly fertile and they must supplement their income by working as wage earners on the coffee plantations in the lowlands. This work is seasonal —the coffee growers need extra manpower only for weeding and cleaning the fields and for harvesting. So the Chamula always manage to be back home for the major religious fiestas—Carnival. Holy Week, Saint John's Day (their patron saint), and *Todos Santos* (All Saints' Day).

It is only about seven miles from San Cristobal to Chamula. Both towns have churches, and the people in each place claim to be Catholic. Yet the differences between Catholicism in San Cristobal and what is called Catholicism in Chamula cannot be measured. In Chamula, the Catholic faith has given little more than a few concepts, a place of worship, and idols. Suffice it to say that in Chamula theology Christ is "our Father the sun"; the Virgin is "our Mother the moon." The Chamula will gladly accept baptism from the Catholic priest who visits irregularly, but all the other sacraments are unknown. The people have their own hierarchy of religious officers, replaced every year, that takes care of the arrangements for the fiestas.

The Chamula, it appears, were Christianized in the sixteenth century, fought this influence, and have largely succeeded in retaining their own system of beliefs, while adopting some Spanish terms and generously borrowing images, idols, and other religious paraphernalia. The Dominicans had to abandon evangelizing in the highlands in the early eighteenth century after a particularly bloody insurrection. More recently, the Mexican Revolution and the subsequent agrarian reform of President Cárdenas (1934) have given the Indians more control over their own affairs, and their religious organization has no room for a Catholic priest. In any case, their views of death and the hereafter reveal that their beliefs are heavily aboriginal.

The funeral I described took place in one of the outlying hamlets, Yalichin, about nine miles from Chamula. Neither the ceremony nor the beliefs inherent in it would be very different in any other part of the *municipio* (a self-administered territorial entity roughly equivalent to a county). Even though funeral ceremonies are private rituals and involve no more than a close circle of relatives and a few neighbors, the rules of behavior concerning death and the handling of it are rigid and strictly adhered to. This matter is important not only to insure a safe journey for the soul of the deceased but also for the well-being of the survivors. When someone dies from any cause other than murder or suicide, the body, if not already there, is brought back home. By the time it has been washed and dressed anew, most of the family are already aware of the death and on their way to the house. Since extended families tend to live in clusters of houses, each couple generally in a separate house, the gathering of kin does not take very long. Even a man's daughters, who often reside patrilocally with their husbands' families, will not live beyond the neighboring hamlets. All of the kin will come and stay in the house of the dead until the funeral is over. This may last from one to three full days, according to the resources of the deceased.

The Chamula believe that a man has two souls: one is an animal companion; the other an immortal principle. The animal companion is born and dies in a one-to-one correspondence with its owner and reflects the events of his life. It is, however, most active at night, in the mountains, where it fights for a living, wards off potent animals, and is exposed to many risks. A man will feel the repercussions of this second life, and in his dreams may even be aware of its happenings. But this animal dies when the man dies or vice versa, one death automatically provoking the other. After death the second soul, which has no special shape or appearance but is sometimes thought to be a manlike creature, will go to the underworld, where all souls live for a time equal to the earthly lives of their owners. Then it will be reincarnated in a person of the opposite sex and in a different situation. A myth describes life in the underworld as the inverse of earthly life. When the sun shines over the earth, it is moonlight down below, and at night the sun shines in the underworld. This is why a man has to be buried at sunset; he will accompany the sun on its westward path to the underworld.

A long wake is necessary for the soul to gather the pieces of the self lost during its lifetime, whether around Chamula or in the hot country (lowlands) where most of the Chamula have worked at one time or another. It is not until those bits (hair, nails, and in some cases, lost limbs) have been collected that the soul can undertake the long voyage to the "land of the dead." Additionally, the wake gives the family an

A widow offers her departed spouse an orange, a lighted candle, and a bouquet of wildflowers.

opportunity to face together the dangers brought by death, help the deceased in his preparation for the voyage, and reunite the kin after a painful loss.

At the same time that the family is called, the professional musicians are summoned. There are some in every hamlet, and they will play without interruption, during the whole wake, the same monotonous funeral dirge day and night. A guitar, a harp, a two-stringed violin, and sometimes an accordion, will alternate and mix their chords, swaying in repetitious rhythm with the wailing and sobbing of the mourners. Music is a part of most Chamula ceremonies, whether public or private. As essential to a ritual as the smoke of incense and the flames of candles, it pleases the gods and keeps at bay the evil *pukuh* ("bad spirits") who hang around the corpse. Everyone in the village will know from hearing the melody that the house is mourning, and nobody will disturb the bereaved. For the wake the family of the dead buys many bottles of *posh*, the local rum produced by clandestine stills, for there can be no celebration without lots of *posh*. The Chamula seem to have an endless thirst for this cheap liquor, not so much for its taste, but because it is considered an offering to the gods. *Posh* is consumed in large quantities according to a strict etiquette, first by the oldest man, who has to address a toast to each of the men there in descending order of rank and seniority, then by the other men in the same order, finally by the women according to their husbands' positions. Although the order of drinking reaffirms the hierarchical principle, each drinker gets exactly the same amount of *posh*, reflecting a fundamental egalitarianism among the Chamula. Similarly, the property of the deceased will be equally divided among all heirs, male and female. So the drinking etiquette is a metaphor for social hierarchy, and at the same time, for equality among all members of society. The *posh* is always mentioned in prayers to the gods and often referred to as *nichim* ("flower"), a ritual euphemism. The men also pass around a bowl of ground wild tobacco, of which they take a pinch to eat. This powder, *moy*, which is extremely strong and bitter, gives strength and clairvoyance by enabling one to see through the night and to defend oneself against the evil spirits. The same substance, according to the myths, allows powerful shamans to transform themselves into strong animals, such as jaguars.

In the state of dangerous uncertainty brought about by the presence of someone who has ceased to live and is not yet in the land of the dead, men need to be as strong and united as they can, so they drink often "to warm their hearts," swallow lots of tobacco (very intoxicating) "to see better," and take great pains not to quarrel during the wake.

In one corner of the deceased's hut, dimly lit by a candle, the corpse lies, head toward the west. It is surrounded by female relatives, one of them wailing until she becomes tired and is replaced by another. In the smoke-filled hut—the hearth is right in the center on the dirt floor and the smoke escapes from the apex of the thatched roof—men keep milling around, drinking, talking, loudly lamenting. When I was introduced to the brother-in-law of the deceased, he burst out in tears, moaning the loss of his relative. As he poured me a drink, he spilled some of the liquor and suddenly switched from tears to a nervous laughter, in which the other men soon joined. Many men eventually become irritable under the influence of liquor, then crumble on the dirt, and pass out for a few hours. There is no contempt for such drunkenness, and the intoxicated ones will be shaken back to their feet if anyone needs them. As the wake goes on, the corpse is fed regularly with a few drops of *posol* ("corn gruel") placed between his teeth.

Women also prepare the goods that the dead will need on his journey: a set of new clothes, a blanket, little bags of food, a rosary stripped of its metallic parts, a few coins "for refreshment on the way," and a tiny drinking gourd. The food consists of the three staple elements of Chamula diet: tortilla, beans, and *posol*. But the dead are different from the living and the tortilla is completely burned, then ground to a fine black powder. Before putting it in small linen bags, each relative takes a pinch of it to his mouth with his left hand. This represents a communion with the dead, who, contrary to the living, cannot use the right hand for eating. If the deceased is a woman, she takes along three turkey feathers representing needles and a spindle; if a man, he is provided with three miniature sticks in order to fight back the animals on his way. From time to time an older relative will come near the corpse and recite a prayer for the dead that will assist him in gaining admittance to the land of the dead.

In a myth that bears an eerie resemblance to the Greek story of Orpheus, the Chamula tell that upon arriving in hell one has to be ferried across a large river by a black dog.

Two Chamula expressions: wonder and innocence, above; audacity, even defiance, at left.

On the other side of the river, a fire burns for which mules—symbolizing punished women—unload firewood. The last element, in spite of its probable Christian inspiration, brings to mind the daily activities of Chamula women who, indeed, collect all the firewood and tend the hearths as strenuously as mules.

The day of the burial proper, the close family of the dead kill all his chickens, which are eaten in equal shares by all present relatives. This reminds one of the ritual use of chicken, the most commonly sacrificed animal, particularly in curing ceremonies. Chickens are symbolically offered to the divinity so that he will admit the dead to the underworld. Upon leaving the house, red pepper is burned in the fire, producing an acrid and unpleasant smoke, the floor is carefully swept, and the door tightly locked. The soul of the dead should not linger around the house, and the smoke of pepper forces it to leave. Even though many relatives sincerely cry at this moment, people agree that they should behave more stoically, for fear that the soul might heed the lamentation and choose to remain in its home.

After this final separation, the procession starts toward the graveyard, located most often on a hilltop "so that the dead may look over the living." The procession stops often, not only to relieve the casket bearers but also to allow women to feed the dead a few drops of *posol*. They will stop more often if the person being buried was old, because then he tires more easily. The walk uphill is a symbol of the journey to the underworld. Once the interment is over and a cross has been erected on top of the fresh grave, the relatives will walk back to the house for a final gathering in order to share the property left by the dead. However, the separation is not completely ultimate. All people who die from natural causes, that is all those who are neither suicides nor the victims of murders, will come back to this world on *Todos Santos*, a time when they are treated with a feast. In each house, the ancestors in the male line will come back and eat the food that has been prepared for them. They will come back to the place where they used to live while the souls of a woman's ancestors will come back to her parents' house, since the Chamula are patrilineal. Those who did not leave anything to their descendants are not expected to return, as if this meeting between the dead and the living were a contractual bond. The Chamula only welcome those of their ancestors who have been beneficial to them. Most of the Chamula who go and work in the lowlands will come back to their parents' houses to join in the celebration of their forefathers. In the house an altar is set, with candles on each side, a sheet of pine needles on the table, a clay incense burner, and bowls of food. The vessels for food are old earthenware used only on this occasion and kept in the family chest the rest of the time. There is meat on the table, cabbage, tamales, *posol*, and salt, all rich and expensive foods. The house cross behind the altar has been decorated with a bow of greenery—pine boughs, branches of laurel, and flowers. Calling the souls of the ancestors, the oldest man in the family starts to sing, accompanying himself on a guitar.

The whole family stands around the altar in clean festive garments. They will wait till the end of the day, then eat what the dead have left. So that the ancestors can recognize the way, the family will have cleaned the grave and decorated it anew with pine boughs and flowers and will have marked the beginning of the path, at the grave, and the end of it, at the house, with pine needles and flower petals. Furthermore, a little stone in front of the house will indicate the entrance.

Meanwhile, at the center of Chamula, the whole body of religious authorities, most dressed in black *chamarras* (ponchos worn only on festive occasions), preceded by the musicians, followed by the civil officials and the ordinary people, will march to the graveyard, next to the old church of San Sebastian. The bells toll, calling for the dead, the music plays the sad melody of *bolomchon* (the "jaguar"). When the procession reaches the graveyard where the tall wooden crosses recently covered with fresh arches of greenery look as vigorous as a spring bush, everyone scatters around the gravesites to tend his dead. On each grave, women set candles, yellow flowers, such as the *flor de difuntos* ("marigold"), or wild orchids, and food offerings—perhaps an orange—presented on a little board. Those of the women who have recently lost their husbands kneel at the foot of the graves and moan and cry and complain of their miserable life. One of them, with her baby slung over her shoulder in a black shawl, might squat by the grave and pour a glass of liquor, muttering: "Ay, my lord, here I have come, I am lonely, here is some *posh*, drink one glass as you used to do, my companion" (the man probably died from excessive drinking!).

In the meantime, the *mash*, young boys wearing comic hats of monkey skin, will dance around the graveyard to the music of *bolomchon*. *Todos Santos* is a day when people are both content and sad. Their dead are among them, partake of the food and drink, listen to the music. But everybody knows that they will be gone tomorrow.

Yet, on this day, in front of the old church of San Sebastian, only one half of the graveyard is freshly cleaned and flowered. On the west side, beyond a little separation, the

burial mounds do not even have crosses, only marking stones, and these are totally disregarded by the Chamula. No relatives around them, no music for these. Here lie the people who were murdered or who committed suicide. They will never be back, for they do not live in the underworld with the other dead and have quite a special status.

Murder is not infrequent among the Chamula. Among the mestizos of San Cristobal and also among other Indians, they are reputed to be violent, especially under the influence of alcohol. It seems that such a reputation is deserved, for the Chamula have a fairly high rate of murder (36 for 100,000 people per year). Yet compared to the incidence of murder in most large Western cities, Chamula is not a dangerous place. Murders usually occur when members of a family quarrel while drunk. There are some cases of women being murdered by their husbands or of presumed witches being killed. Rarely is someone killed by strangers. When a quarrel arises within a family and turns into violence, the murderer will often simply bury his victim in the backyard. But the news always leaks out, or some relative gets worried and warns the authorities. Besides, the Chamula do not try to escape justice when they have committed murder. Most cases of homicide are quickly solved, as if the murderers were too conscious of their religious plight to flee. They rarely resist arrest and appear resigned to their judicial fate.

When news of a murder is received at the municipal center, the president sends out a commission of *mayoles* (officials acting as policemen), headed by a judge. They march to the place of the killing, looking important with their black staffs of office and muzzle-loading guns. They force the alleged murderer to disinter the body. The expedition then walks back to the center, with the accused carrying the corpse, either wrapped in a mat slung over his back with a frontal tumpline, or on his back strapped on a kind of wooden sled. The *mayoles* follow (sometimes covering their noses with white handkerchiefs) along with possible witnesses. While authorities interrogate the suspects (later they will be sent to jail in San Cristobal), a doctor is called to perform the autopsy. The presumed murderer then is expected to dig a grave and bury the dead, all by himself, with no help. This always takes place in the western division of the graveyard of San Sebastian. West, where the sun sets, is the evil direction. Even if the family of the victim is present, there is no ceremony whatsoever, no prayer, no grave goods, and no set time for the interment. The complete absence of ritual contrasts sharply with the elaborate funerals for those who died normally. The only common element is that all are buried with heads to the west.

The Chamula justify their differential treatment of the dead by saying that in a case of homicide, the murderer assumes all the sins of his victim, and the latter goes straight to heaven. This is why in such cases the time of burial is of no importance since the soul does not have to follow the sun. As for suicide, the case is mostly hypothetical: the Chamula say that those people would also go straight up to heaven, but no one I talked to could recall a single instance of suicide. The Chamula are not afraid of the souls of such dead, since once they are in heaven, they are there forever. The murderers have a harsh afterlife in hell, even though they are buried with a regular funeral and on the good side of the graveyard (unless, of course, they were murdered in turn). Murderers never return to earth, neither on *Todos Santos* nor reincarnated.

Thus the cosmos for the Chamula is a sphere, with the sky in the upper portion, and heaven on top of it, the earth as a band in the middle, and the underworld (in Tzotzil, "the sky below") in the lower half, endowed by some with an outgrowth for the murderers. The sun travels visibly across the upper sky during the day, completing its cycle at night when it shines over the underworld. The over-all picture of the cosmos immediately brings to mind the concepts of the ancient Maya. For them, those who had died at war, or women who had died in childbirth, went to heaven and the others went to hell in the underworld. Yet, we do not understand why people meeting a violent end are not cared for in any way by the Chamula.

Women and children huddle restively at the gravesites of relatives on Todos Santos.

In European folklore we can still witness remains of a distinction between the kinds of death. The Church refused to bury murderers, witches, and people who took their own lives. In Russia people who were witches or those who were murdered were buried under public paths, as a sign of contempt. The theme of the castle haunted by one of its former owners who was murdered by his family is a very popular one in Britain. All those people who had not died normally linger on as nuisances and tricksters. At Halloween we are afraid, not of people who died naturally, but of those who died ambiguously. Whereas the "normal" dead are in a definite, well-known (at least in our belief) place forever, the abnormal ones have been denied, for some reason, a permanent haven. They have to be propitiated by men in order to avoid their tricks and malice. The Chamula have an exactly opposite conception: Whereas their "abnormal" dead are in a definite place forever, the normal dead come back periodically and will even come back to earth, eventually. They have to be respected, propitiated, venerated, lest they become harmful.

While the mist spreads around the trees, the old man's wife silently sobs, thinking of the ritual candle she has fixed in his right hand, all wrapped in red ribbons so that they can one day recognize each other and reunite in the underworld. Standing close by, the old reciter mumbles the end of the prayer:

"Where are we going to put him, what place do we have for him?
He lies there crying, he lies there moaning.
Under the cross, under the crucifix,
His face turned to the other side, he looks toward the other side.
Our Holy Father, Our sacred Ancestor,
Take him, receive him."

A Chamula Life

by Nancy Modiano

Drawings by Phil Lohman

Shalik came into the world in the dead of night, bawling, protesting. His mother, Loshah, groaned; his father, Molshun, hugged and pressed the bulging belly; Loshah's mother pushed; and the baby dropped onto the little mound of clothes. For the next two years he probably spent most of his time on Loshah's back, observing the world or sleeping. When he whimpered from hunger the woolen sling was shifted, and from under her arm he would grab at her breast; this was his only "real" food. At night they slept side by side on a hard, wooden platform. He seldom crawled on the dirt floor of their hut, but as he grew he would sit on a blanket, always within her grasp. First steps were encouraged and a stick was held out to guide and support him, but he was not considered able to walk until he could manage the slippery mud trails near home. At first he was dressed in soft, woolen rags, but within a few months, when it appeared that he would live, Molshun bought him a flannel shirt. When he was about a year and a half old and could walk, and Loshah saw that he would not dirty himself too much, she began to weave the first of the rough woolen tunics that would be his principal garment throughout life. At times she talked and played gently with him. At about seven months, for he was a bright baby, he said his first words.

Tortillas and cooked corn gruel were gradually introduced into his diet, and one day he was not allowed on Loshah's back nor was he allowed to nurse. "The breast is dirty; it is full of excrement," she said. He whimpered a bit, then was silent and did not protest. And then another baby, a little girl to help Loshah, was born. When she died a few months later Shalik must have been blamed, at least in part, for the people feel that a displaced child may have such strong ties to his mother that he or the baby may die. The next child, born when he was about four, was again a girl, and she survived. In all, nine of Loshah's ten children lived: seven boys—of whom Shalik was third—and two girls, covering a span of twenty-four years.

As a baby he was very tractable, and therefore good, but as he grew he became very active and more dif-

ficult. He was careless of his clothes, fought with his brothers, and was always playing; a naughty little boy in a world that expected conformity. That he learned to observe the world keenly, to mimic all about him with great exactness, and to speak and joke with skill were traits not particularly commended by his parents. They called him "little parrot"; told him to be quiet, to stop pestering.

Soon he began to help with work about the house. At about four he was taught to take grains off an ear of corn and feed the chickens. When Molshun went for firewood, a small bundle would be fitted up with a rope and slung about his head. Much of the time he followed in his mother's tracks or played near the house.

When it was warm out he liked to play with the frogs near the well, and so he helped by carrying a little jug of water. But if ordered to accompany Loshah in cold weather or before sunup, he refused and cried and was scolded and perhaps spanked. He accompanied her to mind the sheep, and he watched Molshun farm or carve wood near the house. As Loshah sat in the field, pasturing, she spun, and showing Shalik how to do it, left him a piece of thread. Soon Shalik began to learn. By the age of six he was turning out the coarser threads and carding the uncombed wool.

More and more he was sent to mind the sheep, sometimes with his next-older brother, increasingly alone, and always he was given a job of carding or spinning. In addition, he was told to make the grass ropes with which to tie the sheep. But the ropes, and the sheep, were often forgotten as he became more and more involved in his games.

At times he tracked animals and birds, and eventually he developed quite a skill with the slingshot. He trapped many a rat with ropes and stones. Many times he joined in play with other little shepherds. "We would make a swing with a grass rope. If we found a board, we would make a slide. We liked to turn and turn and spin around until we were dizzy and fell down. We liked to jump over ravines and see how brave we were and how wide and deep a ravine we could leap. Sometimes we would pile up a lot of leaves under a tree and burn them; we would climb the tree and stay up there until we couldn't stand the smoke any more and then jump down. If a boy had his back to another, the second might jump up on the first with his hands clasped like a tumpline, to see if he could carry him; or one might grab the arm of another and spin him around and around until they both got dizzy and fell down. We had a game like marbles, but we used little fruits; we would shoot for a small hole, and every time a boy got his marble in all the others would have to give him a fruit. Sometimes we would make a game of planting some dried straw to see if it would grow; if another child pulled it out the next day there would be a big argument.

"We also had a game where one child would close his eyes; the others would hide and then call out that they were ready. The first one would try to find the others, but when he got close they would try to scare him and then run out. Then the one who had scared him first would close his eyes, and all the others would hide.

"Another game was that of burying people. One of the children would take off his tunic, and that would serve as the stretcher. We would gather together some of the tortillas that we had been given, and we would eat them. There are some special herbs that we would gather and use in place of the dead one, and we would bury them. And about a week later we would open the grave and see how the herbs were.

"Sometimes we made a heat bath. We would get together a lot of wood, especially little branches, and light them. And we would sit as close to the fire as we could until we were burning with the heat. All the time we should have been looking after the sheep.

"Most of all I liked to organize the others to build houses. First we would dig a hole in the ground, then find branches and build the roof frame. We would gather grass and tie on the thatching, and perhaps even build one or two walls of branches. The houses were about four feet high and sheltered us from the rain. If the weather was very cold and dry, we would burn the house to warm ourselves. A house stood for a few days, then it was time to burn it and build another. If they discovered us, we were scolded because the hole we dug tore up pasturage or was in somebody's forest plot. I always organized and worked with fear in my heart. But I always built houses.

"As a child, I played a great deal; I had no respect for anybody. I did not understand."

Fire always fascinated him. One day he went to play in the woods, carrying some matches he had bought at the market. He lit some dry grass. It caught, and the fire began to spread. Soon the flames reached the lower branches of the berry trees, and neared the houses. The neighbors were threatened, and men ran out to extinguish the fire. The struggle soon grew desperate, or so Shalik recalls it. He was severely scolded by his father and mother and the neighbors, and his aunts, his uncles, his grandparents, all poured out their fear and wrath.

Once the fire had died he slunk off and squatted near the hearth of his hut. For days he sat, barely moving, not eating, not responding to others. At last his parents took fright and relented, and the *curanderos* ("healers") were called. Herbs were gathered, the correct number of candles and requisite bottle of liquor bought, and three eggs selected. The actual ceremony took place where he had been scolded and overcome with fright, but since he could not move, his shirt was sent in his stead. Candles were lit, prayers said, one egg was broken and buried there, and the liquor was consumed. The other two eggs were returned to the house and cooked; one was fed to Shalik, and the other was shared by the rest. The herbs were also cooked, and after he was anointed with them, more prayers were chanted, and so he was cured and able to run about with the other shepherds.

It was shortly after this that a wedding took place at a neighbor's house. He and his oldest brother went to watch. It was very cold, and the two boys shivered in the icy fog. Nearby, at the edge of the forest, was a little stone cave, and they made a fire to warm themselves. Before going home they very carefully put out the flames, or so they thought. The next morning when Loshah went

out she found their grandfather cursing in front of his house while trying to put out a forest fire. Although he worked as hard as he could, he could not stop the flames. He called the neighbors. The people came from the wedding party. Shalik's parents tried to help. All were furious, they blamed him and cursed him. The grandfather said that if this fire could not be extinguished quickly, he would burn the little boy. Shalik protested and cried he had not done it, but they would not listen; they said they had seen him there. Meanwhile all worked to put out the flames; Shalik ran back and forth, carrying the heavy water jugs. At last they succeeded, the flames were dead, the ground barely smoking, and again Shalik retreated to the hearth, staring ahead, not speaking, not eating. Again the *curanderos* were called, again the candles lit and prayers raised to the gods, and again he was cured.

The monetary demands of the ever growing family pressed hard on Molshun, and more and more he and the two older boys went to the hot country to work for wages on the plantations. One day Shalik was taken to a house in San Cristobal, told to obey the mistress, and left there.

"When I was very very little I began to work for wages in San Cristobal. I was just about six [he was probably about nine], and I cried all day long. I couldn't understand the people at all because they spoke Spanish. By noon I begged to be allowed to leave. 'The day is over,' I said, but they told me to go back to work. By one o'clock I had picked up my tortilla bag and headed toward the door, but they would not let me go. They showed me a clock and said some words, but I did not understand. I had to stay until four."

That afternoon he went streaking up the mountain, but the next day he was returned to the same house. For days tears poured down his face. "I asked for food. They answered, but I did not understand. They gave me fifty cents a day [$.04 U. S. currency], and I swept up their shop.

"Then I began to understand a bit of what they wanted and the strange sounds they said, and I was less afraid. They began to send me on errands, and I found the work easier.

They doubled my pay and gradually kept raising it. I spent many days in that house without leaving. Some days my mother would bring me tortillas, some days they gave me food; I had to spend all my time there.

"When I got home on Saturday evening, my parents would ask me for my money. I would tell them what I had spent. If it was for little things that didn't cost much it was all right. If I wanted bigger things I told them, and sometimes they would buy them for me. So I finally got a leather belt, a hat, a cotton shirt and trousers, but no huaraches [all standard items of Chamula dress]. I have never stopped working since."

Soon Molshun began to take Shalik off to work on the coffee plantations. "We traveled by bus and I was sick for the entire journey. At the plantation I was afraid, for I did not understand the work. In the seven weeks I was there I barely earned any money. But gradually I began to understand what they wanted of me. I returned often, sometimes with my father, sometimes with an older brother. When we went by train I was afraid that I would fall between the cars and be killed. You make good money on the coffee plantations, especially during the harvest.

"There is a weed that grows there. We used to play games by throwing it at each other to see on whose clothes it would stick. When we lined up at 4:00 A.M. for roll call we would push and poke at one another and make a game of it, to see if we could make someone fall and break his food bowl. I was always a little afraid when they called my name. After roll call they would give us breakfast—beans, tortillas, corn gruel, and coffee. At five-thirty we would go out into the fields. At two o'clock we came back for lunch, handed in our work slips, and were given tortillas and beans. In the afternoon we were free to sleep or to wash clothes or go looking for birds or to the store or just rest or do whatever we liked. They also gave us supper: coffee and tortillas, rice once a week, and on one plantation meat once a week. We could buy bread and vegetables on Saturdays. On Sundays people came to sell us food and clothing.

"I was very eager to learn to read and write. My father would not let me go to school; he needed the money I could earn. Nor did my parents dress me well. It was only after I was bringing in my own money that I got a complete outfit. But they have always given to my brothers and sisters."

As he grew Shalik took increasing pride in his ability as a strong and steady worker, one who could always be relied upon to fill in the family's perennial financial crises. Later this same ability would create many difficulties as he became more and more attracted to the material things of the outside world, exceptionally skilled at manipulating in it, yet unwilling to tear himself away from the increasingly illusory emotional warmth of his family.

He would often speak with relish of life on the plantations, but did not

want to go back ever. Between stints in the hot country, and steadily thereafter, he worked in San Cristobal—as houseboy, general laborer, gardener, or at whatever he could get. He liked to garden and, even more, to be sent to market. He learned many skills and began to understand the mysterious Spanish better and better. He could command up to all of five pesos a day ($.40 U. S. currency), but liked best the jobs where a meal was included in his salary. In this way he began to know other foods in addition to the beans, tortillas, corn gruel, and boiled vegetables of his house. He even came to eat the taboo lamb.

"On one job I worked as a gardener for the family of a school teacher. I was given a book and a little explanation of the sounds of the letters. But I did not like the job; the people were very unpleasant and dirty. My oldest brother once tried to explain the sounds of the vowels, but I did not understand. Then on another job, I came across a friend, a mestizo, who showed me again that letters can stand for sounds, and I began to understand." In keeping with tradition he brought gifts of sweet potatoes and beer in lieu of payment. Then he became ill and so the lessons ended. The little that he had learned, he repeated over and over. Later he found another teacher, a carpenter, who charged him two pesos for each four-hour class. Shalik was frightened by the cost and had trouble explaining such a high expense at home, so he left the classes. By then he had begun to read, laboriously but incessantly. On another job where he was able to continue his studies, he saw how to use a typewriter, continued to read, and began to write. His use of Spanish improved, especially as he became interested in a mestizo maid in that house. He began to hear words in English and German, and always the facile imitator, he soon mimicked these words. But Shalik had a strong temper and after a year and a half, furious at being scolded, he left. Next he worked for an American anthropologist from whom he learned more English. He began to understand that numbers written with symbols could be added.

As Shalik's earnings increased he began to contribute a part of them to his family, in addition to the corn he regularly bought; from about the age of fifteen he began to save money. He would soon probably be getting married, his father said.

At about eighteen he began to search for a wife. He knew of two girls who might be available. With relatives, friends, and a special spokesman, with gifts of liquor and money, he stated his request at the first house. The group was quickly and severely rebuffed. To the second house they went many times, with much ceremony. Although it looked as though the people there would eventually give in, he was impatient and fearful of the protracted negotiations. He searched in his heart for a solution. He asked *curanderos*, who assured him that some day he would be married.

One day, thinking of another resource, he invited a friend for a few drinks. After they had both mellowed he asked the crucial question: Was there an eligible girl? And so

Shalik heard of Catalina. With more drinks he wangled an invitation to the friend's house, for the friend and Catalina's father were neighbors. On a second visit he spied the girl and discovered that her father was a friend, that they had farmed near each other previously. After more visits the girl appeared to notice him, and her father asked, "What's that fellow doing around here so much?"

He spied her in the streets of San Cristobal. Another time he saw her at a fiesta in Chamula and pointed her out to his parents. "She looks all right but she's awfully short," they remarked. And she seemed to notice him and not disapprove. At last he decided to make his move, for he was very impatient. For an extra gift he might get her right away. So he bought the usual liquor, the bread, the meat, and gathered all his money (less than $30 U. S. currency). At two o'clock one morning the same group—the community elder, Molshun, Loshah, some relatives, and his friends, all with their wives—started out across the hills. They reached Catalina's house by the first rays of daylight.

The elder spoke. "Good morning, Uncle."

No answer.

"Good morning."

"Oh hell, who is it?"

"Me."

"What do you want?"

"To speak to you."

"What do you want?"

The headman gave a muttered answer and began the formal, chanted request.

"You think I have a daughter? She's not here. Who sent you? How did you find this house?" All were very angry questions.

But the elder stood in the doorway, and the family could not get out. Catalina's father continued scolding, but at last he tired. "You want to see my daughter," and he let the group in to see the girl. The liquor was passed around and they toasted one another. Shalik gave ten quarts of liquor.

Then the father asked, "When are you going to take her away?"

"Why not now?" Negotiations were begun as to how much money and what other things would be given, and all the while they got

drunker and drunker. At last a deal was struck, and the local elders were called. Their decision was that according to custom Shalik would have to stay there for at least three days, the first day at the party, the second and third working for her father. But he could not stay, for he was working in San Cristobal. Then one said that he could take Catalina right away, which was what he wanted. At last permission to leave was given, with the stipulation that they would return for a formal visit within three weeks, and that Catalina would not take all of her clothing with her. That same morning, well before noon, Shalik led his bride to Molshun's house, where again drinks were passed around.

The wedding ceremony was over. Shalik had made no special preparations for his bride. Many years before he had made a bed for himself, for he did not like to sleep with his little brothers, saying that they were dirty and had lice. Nor did the family make any particular preparations. Shalik remained in San Cristobal six nights a week on his job. On returning home he was met by complaints from his parents and the other children that the new wife, aged all of fourteen or sixteen, was lazy, flirtatious, and worthless. Nor did the two have many moments alone, for when he was at home he was not to sit idle and talk; there was wood to be cut and carried, farming, and many other tasks about the house. Molshun had already tired of work; shortly thereafter he would announce his retirement from the world. Even when Shalik sat within the house he was separated from his wife, for he sat with the men on their side of the fire and she crouched near their bed, far from the flames. She cried a great deal. Loshah scolded, and Shalik was torn between the two.

It was at this point that he changed jobs and began working for me as a guide on numerous trips into the mountains. He had to be away for even longer periods, and he did not enjoy his work. In the beginning he had to hike and carry, which annoyed him. Later, with a horse for his own use and other horses for the baggage, he continued to dislike the traveling. The physical rigors were not unpleasant; it was fear of the unknown, of witchcraft.

During the first and the longest of the trips he became ill, with what, at the time, I thought of as increasing depression. He tired easily and slept longer and more profoundly every day, but cried out in his sleep. He had many bad dreams dealing with sickness and death, involving his animal-soul, his true being. After three weeks he went home for a visit, to find his father and a younger brother ill, and to hear tales of Catalina's possible infidelity. He returned to work with tears in his eyes. After that there were more nightmares, but in one dream a man assured him that he could be cured. Shalik knew that dreams forecast happenings and tell one what to do. He decided to look for a *curandero*. Then he discovered a family enemy at a nearby market, far from home. He believed that the man must have come to set witchcraft against his family. Shalik remained outwardly very polite, dressed himself neatly, and tried to smile. But his eyes became very sad and small, usually bloodshot or yellowed. He looked for a *curandero* wherever we went. Finally he found one and impatiently awaited the time of the ceremony. He bought a quart of liquor, thirteen dozen tiny white candles, a box of cigarettes, a bit of salted meat, and, in addition to these purchases, borrowed some money to pay the *curandero*. The whole bill came to approximately $2.50 in U.S. currency. That evening, as it became dark, he set out to spend the night in the *curandero*'s house. The next morning, reassured that he was not going to die, he returned and dreamed a good dream. He said he would become handsome again, and that for the first time on the trip he felt like himself.

As we traveled through the mountains he thought continually of his wife, of her unhappiness, and of how his father was exploiting him. His temper, never very stable, mounted. Within a few months it exploded in a drunken rage against Loshah. He struck her, an unthinkable act in Chamula. The family was shocked, but he was drunk and not to be held responsible for his behavior. A sister-in-law ran up to hold him back, but he struck her down, too. At last the other men, his older brothers and his father, grabbed hold of him and threw him out of the house, where he lay sobbing in the mud. Catalina crouched near him weeping.

"Let him sleep it off there, and he is never to come back into this house," ruled his parents. They gathered up some of his belongings and threw them out into the mud after him. That afternoon, when he woke up and was told what had happened, he fled with his wife to her father's house, where they were allowed to spend the night. To beg forgiveness of his parents he bought the requisite liquor and carried it to their house, expecting that they would accept his apologies and the liquor, that all would drink together and the argument would be over. But Loshah would not touch the gift. She was furious, as was Molshun. So Shalik and Catalina gathered together the things that had been thrown out into the rain and came down to San Cristobal to spend the night. They were very upset; this was the first time they were alone together.

Shalik now laid claim to some land he had bought years before, almost by accident, in obedience to Molshun's orders. There he would build his home. Meanwhile a neighbor allowed him to occupy an abandoned hut. On Christmas Day, carrying all their possessions on two tumplines, the young couple set off for their land. Within one month the roof was up and it was time to make the first of the ceremonies to the gods. Musicians were hired; liquor, bread, and meat were bought; and all who had helped with the house were invited, with their wives. The elder was among those who had helped. He led the chanting, the dancing, and the drinking. All night they celebrated, until they fell asleep in drunken stupors. The next day the work on the walls began. Within another two weeks they too were up, and the second ceremony was held. This time Shalik invited his parents, and they came, but they squabbled with his in-laws. Nevertheless the gods were propitiated, the house would be a happy one, the devils would avoid it. That night all slept in the new house, but the hard feelings remained, between parents and son, between brothers.

Today, having found another job s gardener, Shalik stands a handome young man, well aware of his harm, using many wiles to gain his nds against the mestizos of San ;ristobal. Anger, a search for digity, playing on his handsomeness nd charm, an occasional retreat rom the pressures of life into the lameless infantilism of drunkeness, and most of all, an overriding ear of gossip, which can turn to anic, are major themes in his life.

Life in Chamula and in the neighoring hamlets is closeknit. The gods aust be honored, mostly by good beavior. That which excites the gods, specially envy, may bring accusaions of witchcraft; once thought of s a witch your time is marked. If ou do not leave the settlement, the varmth and mothering of Chamula, ooner or later you will be murdered. Most flee to the big and unfriendly vorld of San Cristobal, but Shalik loes not want to make this move, or o shake off his family, his friends, is whole supportive world. So he ries to behave in outwardly correct orms and to hide his many deparures from the accepted, for the nestizo world, with its many purchasable objects, fascinates him.

He is prone to extremes of mood: elation alternating with depression, fury with joy, humility with the heights of vanity. One should always smile, one should always have happiness in his heart, and Shalik tries to feel that way. Yet there is much sadness in life, and much fear—of gossip, of anger with his parents, of irritations with his wife and employers—and so many a time his eyes become small and bloodshot or yellowed, his words harsh and hostile, and the joking almost desperate in tone. He battles to contain his fury and sometimes almost weeps in desperation. He may seek release in drunkenness. Yet, especially compared with our own older adolescents, he has a realistic picture of his world and has not yet learned to successfully repress all the "improper" emotions; many of his feelings burst out into the open.

Chamula's culture is patriarchal. Authority structures are clearly built and clearly defined. Totik is the principal god, the President of Chamula is the principal priest and secular authority, the father is the ruler of his home (although the mother, being present at all times and responsible for the care of house and children, in actuality is often the dominant person). Authority figures are to be respected and obeyed without question. When a person does not wish to obey, he must be out of the ken of the authority; flight is the most common form of avoidance. When a man has been selected for the Chamula government and chooses not to serve, he flees to the coffee plantations. When a child does not wish to obey his parents, he hides in the forest until he thinks they have forgotten, relented, or gone to sleep. In the presence of authority figures one should be humble and childlike. The most polite tone of voice is that of a child; a person in a formal situation playing the subservient role raises his voice, looks down, and bends over a bit, so that he may appear to be as a child in the eyes of his father.

Shalik handles these authority situations with ease, with a great show of submission and overwhelming modesty, unless his ire has been aroused. Then he becomes rebellious, says hostile things, but stands up for his rights. When facing hostile mestizos in San Cristobal he demands respectful treatment; this is unusual among Indians. Indeed he is one of the few who has learned to deal successfully in both the Indian and mestizo worlds.

What matters to him most today? To work, to earn money, to be able to buy the attractive things of the mestizo world; most of all, to live in peace with the gods and his neighbors.

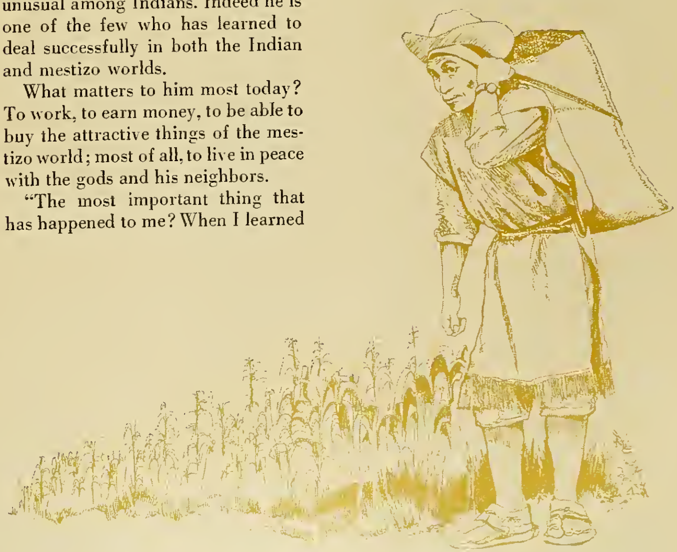
"The most important thing that has happened to me? When I learned how to work and I was able to work by myself in San Cristobal, and when I went to the hot country with my oldest brother. Yes, to work is the most important thing."

The Chamulas know themselves to be Totik's only true children, and yet since the time of the Spanish Conquest they have introduced into their folklore stories of how Indians were born to be humble, to be servants, how it is the mestizo and the Spaniard who use their brains to work, but they are the only ones, while the Indian was made to be a bearer of burdens or a worker with his arms and back. Shalik is an unusually intelligent man, yet when he is drunk he says, "I am stupid. I am ugly. I am dark. I am an Indian."

"You are horrible, you are truly a devil," someone once teased him. "That is your real name, devil."

"No," he laughed, "I am a god." And so he might be, for Shalik becomes Salvador in Spanish—the Savior, the Son, Jesus Christ, and the father of us all, Totik; and so he tries to walk in peace with his gods.

The names of all persons mentioned herein, with the exception of Shalik, have been changed out of respect for their custom of not readily divulging their true names; Shalik asked that his name appear as it does.



Photographing Birds

by Patricia Caulfield

Water birds, songbirds, birds of prey: while each has distinct habits and presents special problems, they do have one characteristic in common that may aid you in photographing them. At nesting time, when sitting on a clutch of eggs or busy feeding their young, they are tied to one location and also less timid than at other times of year. Some individuals can be approached quite closely, sometimes without even resorting to blinds. In his book *Outdoor Photography*, nature photographer Ernie Bauer recounts what must be the most extreme example of the calming effect of avian motherhood. He reports that John Stobie, a conservationist and photographer, almost tripped over a woodcock nest and the setting bird refused to fly even though he nearly touched her. Although it was a golden opportunity, the nest was unfortunately in an impossible location for photography. Stobie decided to try and move it. With the help of friends he carefully dug up a 5- by 5-foot area of ground on which the nest rested, carried it with nest and setting bird to the back of a truck, and drove 25 miles to his studio. The female woodcock stayed on her eggs throughout the trip, the shooting session, and the return trip, when Stobie replaced the nest where he had found it. On checking later he reported that the eggs hatched successfully.

While I've had no such spectacular experiences as Stobie's, I've had good luck with birds without resorting to either blinds or baiting. I photographed a pair of nesting bald eagles several years ago in the Everglades, and the way the project was approached illustrates several essential points about how to take pictures of nesting birds without elaborate setups. First, the nest was spotted by a naturalist friend of mine. He and his colleagues kept their distance, checking it occasionally only through binoculars, until the eggs hatched. As the chicks grew, the observers gradually moved closer to the nest site. When I arrived from New York we airboated through the saw grass to the cypress head where the nest was located.

When we arrived the parent eagle that was on guard flew off to perch on another tree island about half a mile away. In an hour or so it returned and landed on a branch of the tree containing the nest. Unfortunately, the wind was high that day and the sky overcast. I was using long lenses (a 300 mm. and 500 and 1,000 mm. mirror lenses). Even if the eagles had performed as I wished, I knew I'd be disappointed in the pictures—the camera wasn't steady in the wind, even though it was mounted on a sturdy tripod, and the color would be bad because of the overcast. We persisted for about four hours hoping conditions would improve: they didn't, so we left, to return the following morning.

That day dawned bright and clear, and the air was still. When we arrived we were able to approach much closer to the nest without unsettling the attending parent. Fortunately, I refrained from trying different camera angles and stationed myself in one place until I had the one particular picture I wanted. I was trying for a picture of both parents and the two chicks. Less than an hour after setting up in what I thought was the best location, the second adult swooped in to drop prey in the nest, then zoomed off again. Had I been walking around looking for a better position I would surely have missed the picture. Then, for several hours I photographed the remaining parent perched high on one or another of the many cypress branches. I was able to photograph him (or her—bald eagles, like most birds of prey, all look alike except that females usually are larger than males) and the chicks on the nest from a number of vantage points. The adult didn't fly until I was virtually out of the saw grass on the tree island itself, and then, after circling, he would only change his roost to the opposite side of the tiny island. Apparently since my companion and I were drably dressed and moved slowly, and because in the preceding weeks the eagles had become somewhat accustomed to the presence of humans in the vicinity, they had decided we constituted little threat.

I've also photographed nesting water birds without resorting to blinds, and again I've used long lenses. My main experience has been in mangrove swamps in Trinidad and in Florida, and I've had to work from boats. My guides on these occasions have either been experts hired for the purpose or National Park Rangers. Local naturalists such as these are usually in tune with the birds' habits and know best how to approach them. The method of approach can be summed up in a word: caution. When we got as close as my companions felt was advisable for the birds' sense of security, we anchored and sat quietly, tying up to a nearby clump of mangroves that was not being used by the birds. (The species I've photographed in this fashion—scarlet ibis in Trinidad; white ibis, cormorants, and brown pelicans in Florida—seem to nest as close together as possible, but only on certain mangrove islands; hundreds of other nearby islands are empty of them.) While pictures from these trips turned out well, I hope

Announcing the first Natural History magazine

Photographic Competition and Exhibition

Grand Prize
Passage to India
A round-trip air fare for two to Delhi

1st Prize for color and 1st Prize for black and white
A Naturalist's Library

Prizewinners and selected honorable mentions will be placed on exhibition in a special gallery adjoining the Akeley Hall of The American Museum. All photographs exhibited will become part of the Museum's permanent collection. Winners and honorable mentions will be announced in the June-July issue of NATURAL HISTORY. In addition, a selection of the winning photographs will be published.

Photographs submitted should illustrate the following theme:

In nature's infinite book of secrecy
A little I can read.
Shakespeare, *Antony and Cleopatra*

The Judges:

GORDON REEKIE, *Director of Exhibition*
The American Museum of Natural History

JACOB DESCHIN, *Editor*
The New York Times

PATRICIA CAULFIELD, *Photography Columnist*
NATURAL HISTORY

DAVID BROWER, *Executive Director*
Sierra Club

ARTHUR ROTHSTEIN, *Director of Photography*
Look

DEADLINE FOR ENTRIES: March 15, 1968

COMPETITION RULES:

1. All amateur photographers are eligible, except employees of NATURAL HISTORY or of The American Museum of Natural History, or their families.
2. No negatives should be submitted. Entries must be postmarked no later than March 15, 1968. IMPORTANT: No more than two pictures may be submitted by any one entrant.
3. Color photographs:
   a. Color pictures may be submitted as either a transparency or a print. Do not submit both a transparency and print of the same picture.
   b. Transparencies must be originals and must be mounted in cardboard only.
4. All prints (color and black and white) must be approximately 8x10 and unmounted.
5. General:
   a. On the back of the photograph or on the transparency mount *must* appear: name and address of photographer, make of camera used in taking the picture, and the place it was shot.
   b. Developing and printing may be done by a photofinisher or by the entrant. No composite picture, such as multiple printing, multiple exposure, or montage, is eligible. No artwork or retouching on prints or negatives is permitted.
   c. All color transparencies will be returned to entrant only if accompanied by a self-addressed envelope of proper size, bearing sufficient return postage. Black-and-white prints will *not* be returned.
6. NATURAL HISTORY assumes no responsibility for prints or transparencies.
7. Pictures will be judged on photographic quality and originality in treatment of the theme. The decision of the judges will be final.
8. Before receiving a final prize, the entrant must sign a statement that his picture, or any closely similar picture of his of the same subject or situation, has not been, and will not be, offered for publication in any manner prior to July 1, 1968. NATURAL HISTORY retains first publication rights to winning pictures.

PRIZES:

Grand Prize: For the best color *or* black-and-white entry NATURAL HISTORY will provide a round-trip for two to Delhi.

1st Prize color, 1st Prize black and white: A Naturalist's Library: a 50-volume collection selected by Hal Borland, based on the books mentioned in his essay in the January, 1968, issue of NATURAL HISTORY.

Honorable Mention: In addition to the prizewinning entries, photographs selected by the judges for honorable mention will be mounted for a special exhibition in the gallery adjoining Akeley Hall in The American Museum of Natural History.

the next time I work in this way the surrounding water will be shallow enough so that I can stand in it without submerging myself and my equipment. Long lenses are difficult enough to hold steady without having to contend with a rocking boat. My percentage of sharp pictures was still fairly high, but not nearly so high as if I had been on solid ground or even knee deep in mud.

I'd like to mention one other example of working without blinds that is effective with the larger birds. Birds, like many other animals, often do not fear people in cars as much as they do people on foot. If you come across a flock of birds feeding close to a road you will probably be able to drive quite near them. Once the car is stopped you must move with infinite caution. The camera should be ready to go on the seat beside you, an imperative practice whenever you're driving around looking for pictures of any subject. If you have to fumble around in a gadget bag on the back seat, the birds are almost sure to fly away. Roll down the window very slowly, then photograph to your heart's content.

Since I have never made a serious effort to photograph songbirds, I will pass on some advice from Eliot Porter, who specializes in this field. Porter usually works with nesting birds and has taken pictures of them all over the country. He works in color with 4 x 5 equipment and flash at close shooting distances.

When he first started to concentrate on songbirds in the early 1940's, Porter chose nests that were fairly close to the ground and could be reached with a small stepladder. Later he constructed a sturdy 14-foot-high tripodal platform, with steps on one leg so he could climb up and take his pictures. He was able to fold this piece of equipment and transport it around the country attached to the top of his car. He has also resorted to far more elaborate techniques. With a cinematographer friend he once built a 40-foot-high metal tower to reach a rare, high-nesting species.

Another technique that Porter employs to photograph birds in tall coniferous trees is to bend gradually downward the branch on which the nest is situated. He lowers it a few feet a day, bracing it with lumber, nails, wire, and whatever else is at hand. After a little initial confusion

the parent birds accustom themselves to the new position, and the nest can be lowered increasingly greater distances each day as the birds become accustomed to the change. When the shooting is over, Porter leaves the branch in its lowest position; but if there is any danger to the nestlings he reverses the procedure and moves the branch gradually higher. He recommends the branch-lowering procedure only when the chicks are fairly well advanced, not for nests containing eggs or small chicks that need a parent's constant presence for warmth.

Porter photographs his songbirds without using blinds, by simply approaching them slowly and sympathetically until they become accustomed to his presence. I suspect he is successful for two reasons: his knowledge of his subjects and an uncanny ability to find individual birds of each species that are not particularly skittish. A better approach for most of us when working at close distances with almost any wild birds—except such patsies as the penguins and boobies—is to use blinds.

Basically, a blind is anything that will conceal you, and your movements, from the birds. You can construct a portable blind that can be dismantled and re-erected on location; you can erect a blind on a location using materials found on the spot, such as rushes, reeds, foliage; if you want to photograph in a fixed location over a period of time you may prefer to construct a wood-framed blind. The best material for covering blinds is a double layer of burlap. Cut slits in the material for the camera's lenses. Instead of going to the trouble of constructing a blind, you may prefer to use a small tent, again photographing through small slits.

Move the blind closer to the nest gradually, starting at a distance of 10 to 15 feet and moving in at the rate of 2 or 3 feet a day until you are sufficiently close to your subject. Incidentally, some birds will sense that you are in the blind even though they can no longer see you. If the subject refuses to return to the nest, have another person enter the blind with you, then leave. This will fool most birds. Others, however, will steadfastly refuse to be outwitted, in which case the only alternatives are a game of wait or a search for another bird.

Book Essay: The Naturalist's Library

by Hal Borland

The best personal libraries just grow. Mine happens to be a reference library specialized to my needs as a writer, but it began when I was a young amateur naturalist full of questions. When I found a book that gave me answers I bought it as soon as I could spare the money. But answers, facts, can take one only so far. Eventually I needed books that gave me ideas and posed questions for *me* to answer about man's relationship to the whole intricate web of life. My library grew and changed, as a healthy library should. It is still changing. But if I were starting today I would again begin with the answer books.

I don't know whether handbooks were rare or whether I was slow in finding them, but it seems that there are many more available today. Any guide that answers your questions is worth owning, at least until you find a better one. Even the paperback "Golden Nature Guides," although limited in scope and oversimplified, are excellent for children and beginners. There are several hardback series, but I rely on selected volumes of the Houghton Mifflin "Field Guides" and the Putnam "Field Books" for everyday use. I prefer Peterson's *Field Guide to the Birds* and Cobb's *Field Guide to the Ferns*, for instance, and Mathews' *Field Book of American Wild Flowers*. For trees I use both Petrides' *A Field Guide to the Trees and Shrubs* and Mathews' *Field Book of American Trees and Shrubs*. For birds I also use Pough's *Audubon Bird Guide* from a Doubleday series.

If I were limited to a very few books, I certainly would get the Collins *Complete Field Guide to American Wildlife*, a Harper book packed with information about birds, mammals, fishes, reptiles, amphibians, even seashells. I wish there were a comparable handbook about plant life, but I have never found one.

There are handbooks and guides for subjects ranging from rocks to stars, from animal tracks to freshwater ponds. I have fourteen of them on the reference shelf beside by desk. But from time to time their compressed information needs elaboration, so on my shelves also are such books as *Gray's Manual of Botany*, Muenscher's *Weeds*, Forbush's *Natural History of American Birds*, Hylander's *The World of Plant Life*, Guyer's *Animal Biology*, Wigglesworth's *The Life of Insects*, Welty's *The Life of Birds*, the Milnes' *The Senses of Animals and Men*, Kieran's *Natural History of New York City*, Teale's *Grassroot Jungles* and *Near Horizons*.

Two irreplaceable references are the encyclopedia and the dictionary, believe it or not. Here in my study I have the multivolume *New International Encyclopedia*, an old edition, but the facts of natural history haven't changed much in the past twenty-five years. Downstairs in the library are the recent *Britannica* and the one-volume *Columbia*. I use them all, on occasion. Even more often I turn to *Webster's New International Dictionary*, unabridged, second edition, here beside me. At the flip of a few pages it will give me the chemical formula for the chlorophylls, even remind me that there are two forms; it will identify for me an epicalyx, a horntail fly, or a terebra. And all without wasted words.

There are other "fact" books, quite a few of them on my study shelves, but most merely supplement or duplicate books already mentioned. There are half a dozen almanac, or round-the-year, type of books, headed by Peattie's classic *An Almanac for Moderns*. There are even two of my own books, timing reminders for my own area. There are a half-dozen insect books, simply because I never have found a really good over-all book on entomology. Lutz's *Field Book of Insects*, although swaybacked with taxonomic detail, still has much readable information and is the best insect guide I know. But I go to Evans' *Wasp Farm* and to Klots's *Field Guide to the Butterflies*, for example, to get special information. And I wonder why insects are so much harder to write simply about than are plants or birds. There is also Saunders' *A Guide to Bird Songs*, LaMonte's *North American Game Fishes*, Curran and Kauffeld's *Snakes and Their Ways*. There is a three-volume set on animals that isn't worth shelf space. There are six volumes of the excellent paperback "Scientific American Books," *Plant Life*, *The Planet Earth*, *Lives in Science*, *The New Astronomy*, etc. There is a broken set of Fabre, several volumes of Burroughs, a set of Thoreau, all picked up long ago in used-book stores.

But we now have begun to move over from the fact books to those for enjoyment and armchair participation. The line, of course, is hard to draw, and there are constant overlaps; I don't think there is one enjoyment book on my shelves that didn't tell me something I didn't know. There isn't room here to inventory those shelves, for they contain about five hundred books. But in one section are seventy-odd volumes that are a chosen group. In one sense they are the cream of my own library. They are books from which I selected

virtually all the material for a fat anthology entitled *Our Natural World* and published by Doubleday in 1965.

In that book I attempted to create, primarily out of my personal library, a picture of outdoor America, the look and color and sound and smell of it, the almost incredible variety of the land, and the life that is native to it. It included excerpts from books by authors from Audubon to Alexander Wilson, from Durward Allen to Stewart Edward White. The bibliographical index at the back of that book lists eighty-eight books or magazine articles, every one of which has given me hours of pleasure and information. Here is a sampling:

Durward L. Allen's *Our Wildlife Legacy*, Mary Austin's *Land of Journey's Ending*, William Bartram's *Travels*, Henry Beston's *The Outermost House*, Maurice Broun's *Hawks Aloft*, John Burroughs' *A Year in the Fields*, Sally Carrighar's *One Day on Beetle Rock*, Rachel Carson's *The Edge of the Sea*, Lewis and Clark's *Journals*, William O. Douglas' "My Wilderness" books, Gustav Eckstein's *Lives*, John Ehle's novel *The Land Breakers*, Loren Eiseley's *The Immense Journey*, Paul L. Errington's *Of Men and Marshes*.

Also, Peter Farb's *Face of North America*, Hugh Fosburgh's *One Man's Pleasure*, Lewis Gannett's *Cream Hill*, Leonard Hall's *Stars Upstream*, Louis J. Halle's *Spring in Washington*, Joseph Wood Krutch's *The Desert Year*, Aldo Leopold's *A Sand County Almanac*, Lorus and Margery Milne's *A Multitude of Living Things*, John Muir's *The Mountains of California*, Sigurd Olson's *Runes of the North*, Donald Culross Peattie's *Singing in the Wilderness*, Roger Tory Peterson's *Birds Over America*, Marjorie Kinnan Rawlings' novel *The Yearling*, Wyman Richardson's *The House on Nauset Marsh*, Ernest Thompson Seton's *Lives of the Hunted*.

And, finally, Robert Ruark's *The Old Man and the Boy*, Edwin Way Teale's *Journey Into Summer*, Betty Flanders Thomson's *The Changing Face of New England*, Thoreau's *Walden*, Mark Twain's *Life on the Mississippi*, Stewart Edward White's novel *Folded Hills*, Walt Whitman's *Specimen Days*, Alexander Wilson's *American Ornithology*.

The novelists mentioned are on the list because they were good observers and accurate reporters of the natural scene. A number of the authors are represented on my shelves by more than one book: Teale, for instance, Peattie, Krutch, the Milnes, Eiseley, White. The Teale book listed is one of his four-volume "Seasons" series. White's novel is one of a trilogy. Leopold's *A Sand County Almanac* is now available in a new, expanded edition.

I will buy and keep anything Loren Eiseley writes. I keep close tabs on the new books of Peter Farb, one of the very best of our younger naturalists. I prefer Alexander Wilson to John James Audubon on birds, though I have both on my shelves. We all have our prejudices and preferences, and an honest library will reflect them. One of my unconventional reading habits is to search out the good, occasionally excellent, entries in the U.S. Department of Agriculture Yearbooks. They are often worth my time as a naturalist and ecologist. Four of the yearbooks, those entitled *Grass*, *Trees*, *Water*, and *Seeds*, are well worth my shelf space.

The best libraries, as I said to begin with, just grow and usually keep changing somewhat. Inevitably, they reflect the owner's mind and interests. We could discuss this all day and into the night, book by book, author by author. But books are written to be read, not talked about. Read and kept, perhaps. Kept books are best.

Hal Borland is a naturalist, essayist, and author, whose most recent book is "Hill Country Harvest." Mr. Borland also writes the nature editorials for The New York Times and is a frequent reviewer of books on natural history.

The Shorebirds of North America, edited by Gardner D. Stout, with text by Peter Matthiessen, paintings by Robert Verity Clem, and species accounts by Ralph S. Palmer. *The Viking Press, $22.50; 270 pp.*

This is one of the finest books of natural history that I have ever seen, regardless of its qualities as an ornithological text, which are considerable. Not the least of the assets of *The Shorebirds of North America* is its feeling of scope, a sense it provides of the worldwide environment in which these "wind birds," in Peter Matthiessen's phrase, have their various being. In other words, this is not just a glossy teaser for the uninitiated; it has authentic unity and depth.

The 32 full-page illustrations, by Robert Verity Clem, of the shorebirds most commonly seen, are highly skilled, precise not only in terms of the feathering and other characteristics of the birds but in the details of their environment. They are strong paintings in their own right and have the dignity of first-rate landscapes. The method of these plates, when there is more than one species illustrated, is to put the birds in the ecological relationship in which they are likely to occur together —the semipalmated and piping plovers, or the avocets and the phalaropes.

Peter Matthiessen's text has the deftness and balance of a fine writer, it is a mosaic of fascinating information, of observation and description expertly placed. He ranges the field from the fringes of this continent to its interior—not to mention his use of collateral avian associations in many other parts of the world—giving innumerable examples of ways of flight, of mating and nesting, and of distraction and displacement behavior. In a relatively short number of pages we are given the wide realm of shorebirds not only in fact and detail but in their beauty of action, in so far as words can accomplish it.

Ralph Palmer's accounts in the Appendix of the seventy-five species that occur on this continent, treating plumage, aids to field identification, voice, habitat, distribution, migration, breeding, and habits, are as careful and thorough a scientific contribution as can be found.

In an age of confusion, this reader is grateful for the precision shown in this book, its faithfulness to its subject, its realistic skill. It is worth a great deal more than its price.

John Hay
Cape Cod Museum of Natural History

North American Mammals, by Roger A. Caras. *Meredith Press, $19.95; 578 pp., illus.*

Bird watchers and bush sniffers have had numerous guides to their hobbies; with this new book, mammal seekers are no longer neglected. The versatile author (a screenplay and natural history writer, former television actor, photographer, and world traveler) has designed *North American Mammals* to help the reader locate, identify, watch, and photograph our native mammals as they pursue their normal lives in their natural habitats. He presents sprightly accounts of the groups (usually genera) that inhabit the continent and its adjacent ocean waters north of Mexico. (Contrary to the subtitle, *Fur-bearing Animals of the United States and Canada*, the book is not limited to animals whose pelts are utilized by man.)

A great deal of information is assembled on history, names, and range (with good-sized, clearly drawn maps), appearance, distinguishing characteristics, habits, and reproduction, as well as methods and specific places for observing the species. An 85-page series of appendixes supplies classification, a life list (with blanks to fill in), tables of breeding facts, habitats, state and provincial checklists, national parks and refuges, conservation organizations, and a bibliography. There are sketches of tracks, many photographs (reproduced by offset), and four handsome paintings by Charles Fracé.

Chatty directions, helpful hints, and sensible warnings encourage and for-

tify the mammal watcher. The author's enthusiasm and sympathy enliven every page. A serious reader may find the informal style too colorful in spots (the otter "invented water polo") as well as too personal (most genera or species and all individual animals that are not obviously female are designated "he"). More serious criticism results from the plethora of loose statements with a considerable number of inaccuracies, several mistakes in range maps, and some poor choices of localities to observe designated species. While the book offers a great deal of useful knowledge with interest and vigor, it has more than its due share of errors.

VICTOR H. CAHALANE
Zoologist and Author

POLYNESIAN ART, by Edward Dodd. Vol. 1 of "The Ring of Fire," *Dodd, Mead & Co., $25.00; 368 pp., illus.*

Art traditions often had a life and death importance to the island cultures of the central Pacific. Today, most of these cultures have been greatly altered through 400 years of colonization, and their art is available to us only in museum collections or as photographs in books. The material objects pictured in Edward Dodd's *Polynesian Art* would make an exciting exhibit. Photographs of 450 individual pieces, ranging from shell fishhooks to carved and decorated figures, make up the bulk of the book. This selection is evidence of the taste and interests of the author, a man particularly impressed with the Pacific peoples. The photographs represent the pre-colonial art situation and, he contends, demonstrate an over-all Polynesian culture.

Rongo, the god of fertility, bestowed offspring on mankind and came down from the skies in rain to make crops grow. From "Polynesian Art."

Dodd implements his argument by arranging the objects according to theme rather than by island group. A text section concerns the mechanics of migration, subsistence patterns, and the social backgrounds of art. A disclaimer that the text is "summarial and speculative background material . . . addressed frankly to the amateur" is overmodest. He has examined the most recently published scientific works and has had contact with outstanding Pacific scholars. His background includes experience sailing among the islands, and he has learned to know some of the present-day islanders. Beneath an informal literary style, Dodd makes a serious attempt to improve the art history of the area.

This handsome book will be a resource for students, with its gallery of both well-known and rarely seen works of art. Questions will undoubtedly be leveled at the author, particularly for his "irregular notions" on the origin of the Pacific peoples and the causes of their migration, but his attempt to relate art to the culture offers much to consider.

PHILIP GIFFORD
The American Museum

ANTS FROM CLOSE UP, by L. Hugh Newman. *Thomas Y. Crowell Co., $6.95; 112 pp., illus.*

It is so easy to find analogies, real and imaginary, between ant societies and human societies that the authors of many popular books on ants fall into the trap of attributing human motivation, thoughts, and desires to these insects. That this anthropomorphic approach is not necessary in order to write an interesting and informative book for the layman is evident from L. H. Newman's *Ants from Close Up*. This book is profusely illustrated with beautiful "close-up" photographs of many aspects of the life of different species of ants. Most of these were taken by Stephen Dalton.

The book begins by discussing the relation of the ants to other social insects, followed by a description of their anatomy, metamorphosis, and sex determination. The remainder of the book is devoted to sections on feeding, reproduction, care of young, colony formation, and aggression. An interesting chapter describes the development of parasitism among ants, giving examples of different degrees of parasitism shown by different species. Another fascinating chapter describes the African driver ants and South American army ants, both of which have been grossly misrepresented in exaggerated movies and horror stories.

The contributions of many well-known students of ant life are briefly

discussed and there is a short bibliography and index.

MADELINE L. COOPER
The American Museum

Briefly Noted

ANCIENT MAYA RELIEF SCULPTURE. Rubbings by Merle Greene, Introduction and Notes by J. Eric S. Thompson. *The Museum of Primitive Art, $15.00; 60 pp., illus.*

Lowland Maya sculpture, one of the great art styles of ancient America, is beautifully presented in this book of rubbings by Merle Greene. The result of four summers work, the rubbings offer, in many instances, the first detailed view of low-relief sculpture found in the dim interiors of ceremonial buildings or inaccessible areas.

PROGRESS INTO THE PAST, by William A. McDonald. *The Macmillan Co., $9.95; 476 pp., illus.*

A biographical and historical approach to the accumulating archeological evidence dealing with the Mycenaean civilization with the focus on the works of Schliemann, Evans, and Blegen. The reader is brought up to date on current theories and problems and is assisted by an ample glossary, a series of maps, and suggestions for further reading.

A DEAD WHALE OR A STOVE BOAT, by Robert Cushman Murphy. *Houghton Mifflin Co., $8.50; 176 pp., illus.*

A fascinating record of a whaling voyage made by the author in 1912 on a Yankee square-rigger. The photographs, taken more than 50 years ago, capture the flavor of old-time whaling as well as old-time photography.

ESKIMO PRINTS, by James A. Houston. *Barre Publishers, $12.50; 110 pp., illus.*

James Houston, a painter and civil administrator for the Canadian federal government, spent ten years with the Baffin Island Eskimos and introduced them to the art of print-making. The result: a boost to the economy of a seminomadic people and this striking collection of 48 prints showing the range of skill and the delightful imagination of the Eskimo artist.

PENGUINS, by John Sparks and Tony Soper. *Taplinger Publishing Co., $8.95; 263 pp., illus.*

The authors have provided a lively account of the penguin with an enthusiasm for their subject that will surely be catching. Photographs, line drawings, and diagrams aid in recounting the life history, discovery, and exploitation of these engaging birds. Notes on the seventeen species and a short appendix on penguins in captivity round out the narrative. C.B.

Letters to the Editor

Pleistocene Overkill—
A Criticism

I shall confine myself to commenting on some of the more obvious confusion in Dr. Paul Martin's article ("Pleistocene Overkill," NATURAL HISTORY, December, 1967), and shall deal with some misunderstandings concerning the true facts of the situation in respect of the Continent I know best—Africa.

First of all, dealing with general matters, Martin confuses the issue when he does not make it clear what period of the Pleistocene he is really concerned with. We find the following different statements in the earlier part of his article: "About ten thousand years ago . . . as man moved southward *at the end of the last Ice Age* [my italics] North America suddenly . . . lost most of its large animals."

The implication here is that the extinction Martin is concerned with took place after the close of the Pleistocene proper, during what most geologists would regard as the Epi-Pleistocene period. A few lines later, however, he writes: ". . . this fantastic loss of large animals *during the Pleistocene* [my italics]." This is not at all the same thing as "About ten thousand years ago. . . ."

Later on again, in the fourth paragraph, we read: "the extinction that took place at the end of the Pleistocene. . . ." which is nearer, but does not quite agree with his opening words. Still further on we find: "Late Pleistocene extinction far exceeded replacement" which is not the same as "at the end of the Pleistocene," nor "during the Pleistocene."

When he comes to write about Africa, he writes: "today's living megafauna in Africa represents only about 70 per cent of the species that were present during the Late Pleistocene."

This statement is categorically not correct. There were several periods of extinction of fauna (both megafauna and smaller animals) during the Pleistocene of Africa, but the last of these of any significance was at the close of the *Middle* Pleistocene. All the available evidence indicates clearly that the fauna of the Late Pleistocene of Africa, south of the Sahara, was practically identical to that of today.

Next Dr. Martin writes: "the proportion of African mammals that perished [in Africa] during the Pleistocene was less than that in North America. . . ."

This is an incredibly vague statement. There was very considerable extinction of genera and species at the close of the Early Pleistocene. This was followed by another major period of extinction at the close of the Middle Pleistocene and there had earlier been some less extensive extinction halfway through the Early Pleistocene. The extinction, on the other hand, that Martin has been referring to throughout the first part of the article is only that which took place *after* the last Ice Age and at the end of the Pleistocene. In Africa we had negligible extinction at that time.

Another statement of Martin's which needs elucidation is: "In addition to the large mammals that now inhabit the African continent, an imaginary Pleistocene game park would have been stocked with such species as the antlered giraffe, a number of giant pigs, the stylohipparion horse. . . ."

This statement does not really agree with the facts. In the first place, he does not say at what stage of the Pleistocene his "imaginary Pleistocene game park" is being situated. Certainly such an imaginary game park in the Early or the Middle Pleistocene would *not* have had the majority of "the large mammals that now inhabit the African continent." There are exceedingly few species on record from the Early and Middle Pleistocene that are the same as those which represent the megafauna of Africa today. If, on the other hand, his imaginary Pleistocene game park is placed in the Upper Pleistocene, then the megafauna would be practically identical with that of today, but *without* the extinct species that he quotes.

I find the following bold statement very hard to accept and wonder upon what it is based: "In Africa, as in America, the wave of Pleistocene extinction took only the large animals."

I very much doubt whether it is true of America, but I leave that to my American colleagues to discuss that issue. For Africa it is not true.

Two other statements which need comment are: "African big game extinction appears to coincide . . . with the first record of fire, or at least of charcoal, in archeological sites," and "most extinct fauna is last found . . . associated with the distinctive stone tools of early Stone Age (Acheulean) hunters."

The implication, therefore, is that Acheulean man was the cause of the extinction of many African species and that he did so at a time when he used fire widely. I do not know more than two sites of Acheulean culture in Africa where there is clear evidence of the use of fire.

Towards the end of his article, Dr. Martin suggests that perhaps the reason why extinction was so rapid, at the hands of the American Palaeo-Indian hunters, was due to the fact that: "To capture *any* member of a bison or elephant herd, it was necessary to kill them all . . . by driving them over a cliff."

While it is not denied that there is some record of herds of animals being driven over cliffs by primitive hunters, the vast majority of available evidence suggests that Stone Age hunters hunted individual animals and, after all, the hunters in America, of the time Martin is writing about, were essentially the projectile point peoples.

There are two sentences in the concluding stage of this article which read: "To discount the hypothesis one need simply identify a major wave of extinction anywhere in the world in the Late Pleistocene prior to man's arrival," and "The essence of the argument is based upon the simple matter of Late Pleistocene chronology. In no part of the world does massive unbalanced . . . extinction occur without man the hunter on the scene."

I will comment on these sentences by stating the essence of the argument *against* Dr. Martin's hypothesis, so far as Africa is concerned:

The main extinctions of African faunas took place before man was at all widespread and before he pos-

sessed really good hunting weapons. On the other hand, during the Upper Pleistocene, Upper Palaeolithic man in Africa became a very proficient hunter, using all kinds of hunting weapons. He increased in numbers and became still more proficient through the Mesolithic and the Neolithic. His hunting prowess and weapons were even better in the Iron Age. Nevertheless, in spite of great numbers of hunters and their ever increasing proficiency in hunting weapons, man in Africa completely failed to exterminate the large megafauna of the Continent. during the Upper and the Post-Pleistocene period. It seems to me that this fact alone completely disproves Martin's contention that extinction in Africa was essentially due to human intervention.

L. S. B. Leakey
National Museum
Centre for Prehistory and Palaeontology
Nairobi, Kenya

In Rebuttal

A lifetime devoted to the search for fossil hominids and associated fauna of East Africa uniquely qualifies L. S. B. Leakey to comment on crucial events of the past. Unfortunately I failed to persuade him of the merits of the overkill hypothesis, a subject we have debated elsewhere (*Nature*, Vol. 215, No. 5097, pp. 212-213, 1967).

Some of Leakey's objections deal with my definitions, or lack of them. By Pleistocene I mean the Ice Age of the last few million years, up to the present. By "Late Pleistocene" I meant what many laymen might imagine the term to mean—roughly the latter part of this time period. Unfortunately, the adjective "late" was capitalized, and to geologists studying Africa, the boundary between "Middle" and "Late" Pleistocene has been established as occurring at a more recent date than the one to which I refer in my article. The existence of this boundary somewhat obscures the fact that there *was* a major reduction in African large mammals, including giant pigs, antlered giraffe, and various bovids, by about fifty thousand years ago, well within the time period to which I referred in my article, but prior to what Leakey means by "Late Pleistocene." Regarding more critical faunal comparison, paleontologist Cooke has indicated that about 26 genera of large mammals disappeared from Africa at that time. About forty thousand years later North America suddenly lost some 35 genera. These episodes were the only periods of accelerated Pleistocene extinction in either of these continents. Depending somewhat on one's method of classification, the preceding several million years—most of the Pleistocene—saw the disappearance of only 19 genera in Africa and 13 in North America. A vast difference in extinction rates between Early and Late Pleistocene is apparent.

If the Late Pleistocene extinction had included small mammals not easily affected by human predation one would be obliged to seek an explanation other than the overkill hypothesis. Admittedly, the record for small mammals in the African Pleistocene is poor through no fault of Leakey, who has done as much to enrich it as

anyone else. But in Leakey's book on Olduvai Gorge, paleontologist Lavocat reported that the Olduvai Bed I rodent remains are seemingly identical with, or very near, today's living fauna, indicating that extinction did not affect these creatures. Similarly, Hibbard's summaries for North America reveal no genetic extinction of small mammals coincidental with that of the mammoths, mastodons, camels, and ground sloths.

The idea that extinction of the African megafauna was caused by

hand-ax hunters of the early Stone Age was expressed by Clark in his *Prehistory of Southern Africa* (1959). If archeologists now can *prove* that the hunters using hand axes were definitely too few in number or too feebly equipped to cause a faunal upset, we could scrap the notion of overkill. But the fact that younger and more sophisticated cultures, ours included, did not exterminate as many genera of large animals is no argument. The first clever and suitably equipped Stone Age hunter to appear on the scene in either Africa or America had a unique opportunity. The surviving large mammals were either selected for, or were obliged to evolve, defensive adaptations against the hunters. It is also possible that later hunters learned or practiced sustained yield harvesting of their prey. In any case, the large-scale megafaunal extinction of which I speak had already occurred by the time the younger cultures came on the scene, and therefore it is to be expected that these later societies would have a lesser potential than their forebears for causing widespread extinction; one cannot exterminate the already exterminated.

While I welcome the chance to field some of Leakey's criticisms and while I recognize that many additional points could be raised, it seems that the main issue has not been confronted. In brief it is that in Africa, sometime about fifty thousand years ago, there occurred a wave of unbalanced extinction not clearly related to climatic or environmental upset. The pulse of extinction spread with a growing intensity into other parts of the world. To the best of our knowledge the pattern seems closely linked with only one event, the spread of prehistoric man. Leakey has neither demolished this generalization nor proposed any reasonable alternatives.

Paul S. Martin
Department of Geochronology
University of Arizona

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Suggested Additional Reading

A SONG OF SAN FRANCISCO BAY

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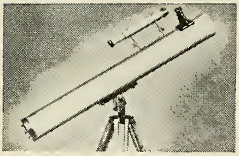

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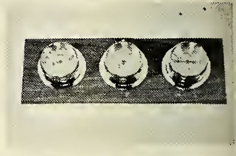

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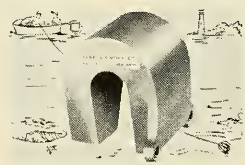

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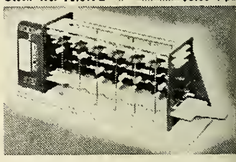

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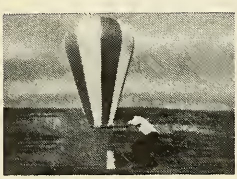

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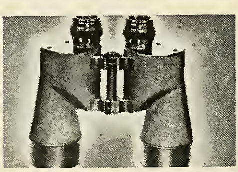

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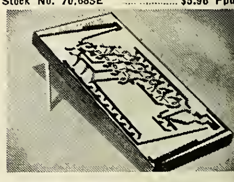

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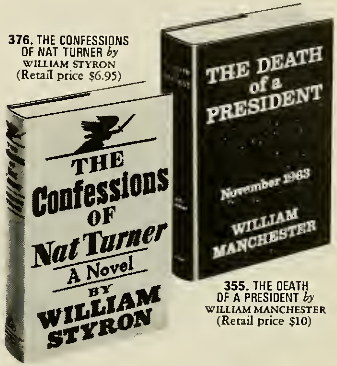

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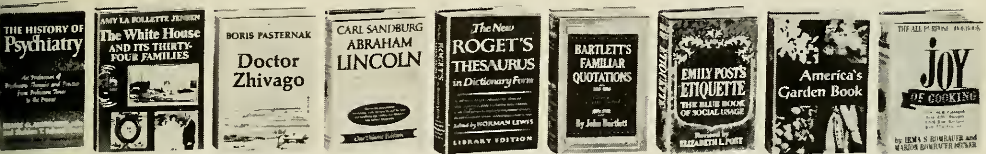

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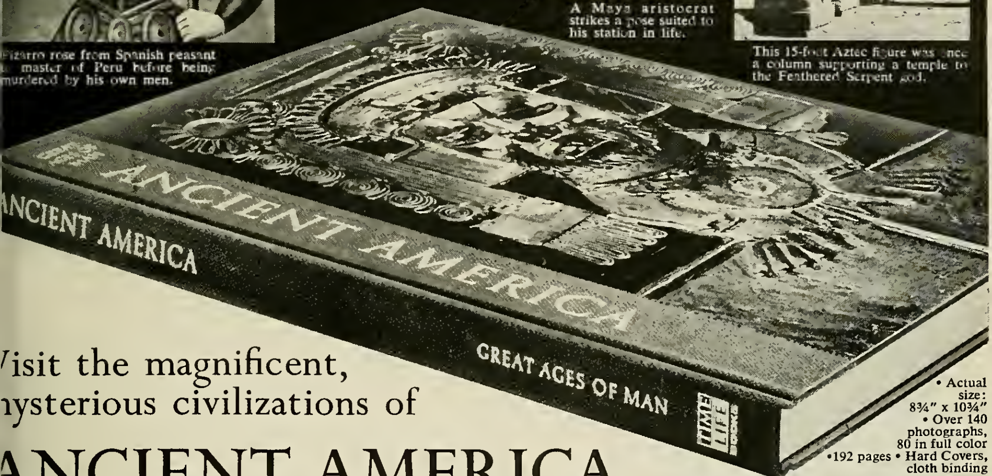

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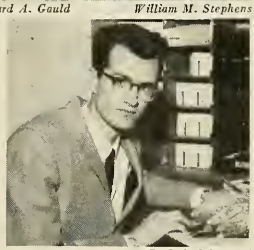

Paul A. Johnsgard

In this issue, JACK HOPE, Associate Editor of NATURAL HISTORY, offers a second article on the subject of parks. (His first, dealing with a metropolitan park system, appeared in our August-September, 1967, issue.) This time he explores the effects of population and prosperity on the natural areas within the National Park System. Before joining the staff of NATURAL HISTORY, Mr. Hope authored several articles on conservation and related topics. He is a graduate of Cornell University and holds the M.A. degree in economics from that institution.

Formerly reporter and photographer for the *Detroit News* and *Pacific Stars and Stripes* and city editor of the *Middletown* (New York) *Record*, ALAN TERNES is presently a doctoral candidate at Columbia University, where he earlier received a B.S. degree in geography. Mr. Ternes is primarily interested in the ecological approach to geography and in reconsidering the theory of environmental determinism. With the aid of the computer he hopes to outline the effects, real and spurious, that the ecological setting has on the populations of various areas.

HOWARD E. EVANS' special bailiwick in the insect world is wasps. He has spent the last three summers at the Jackson Hole Research Station in Moran, Wyoming, studying the digger wasp group. Dr. Evans completed his doctoral work in zoology at Cornell in 1949, and spent the next eleven years teaching first at Kansas State University and then at Cornell. In 1960 he was appointed Associate Curator, then Curator of Insects at Harvard's Museum of Comparative Zoology. Dr. Evans has authored more than 100 papers and three books, almost exclusively on wasps. His book *Wasp Farm* was published by the Natural History Press in 1963.

After receiving his Ph.D. from the University of California at Berkeley in 1965, RICHARD A. GOULD was appointed Assistant Curator of North American Archeology at The American Museum of Natural History. During his undergraduate days at Harvard, Dr. Gould spent his s
mers in the Glen Canyon area of U
conducting salvage archeology in
area now largely occupied by I
Powell. This field experience, plu
ethnographic study of the Tol
Indians of northwestern Califo
while at Berkeley, served him
when, under a grant from the So
Science Research Council (U.S.)
and his wife, Elizabeth, spent s
fifteen months with the Austra
aborigines in the area of the W
burton Range.

When WILLIAM M. STEPHENS
ceived his LL.B. degree from
University of Tennessee in 1950
was already an avid amateur o
nographer and marine biologist.
years later he returned to the U
versity of Miami to do graduate w
in the field of ocean life. He
written numerous scientific pa
during some fifteen years of exp
ing subtropical waters, both on
below the surface. He is also
author of *Our World Underw*
and *Science Beneath the Sea.*
latest book, entitled *Southern*
shores, is due next month from H
day House. Mr. Stephens is curre
the managing editor of *Oceanol*
International.

PAUL A. JOHNSGARD's studies
the behavior of waterfowl have ta
him to the far reaches of the gl
After receiving his Ph.D. degre
zoology from Cornell in 1959
spent two years in England study
the behavior of the family Anati
—ducks, geese, and swans. All in
he has researched 138 species
waterfowl. Dr. Johnsgard has d
intensive work with the specta
eider in Alaska, the musk duck
Australia (NATURAL HISTORY, O
ber, 1965), the torrent duck in S
America, and with many specie
grouse (NATURAL HISTORY, Ma
1967). An Associate Professor
Zoology at the University of
braska, he is presently turning
attention to the waterfowl and q
of Central America. Dr. Johnsgar
the author of the forthcoming *Wa*
fowl—Their Biology and Nat
History and of the *Handbook*
Waterfowl Behavior.

About ninety feet nearer my God to Thee:

Prosperity and the Nation

Driving into the valley, you can see the falls. As the rushing water leaves the gray granite cliff to leap into space, it is whipped into frothy whiteness; and continuing its wild fall, the stream of white widens quickly, then hits the rocks below. The impact shoots the flying droplets upward and outward, but they fall again and instantly gather to slide and pound in a furious rush down the mountainside, pausing here and there to eddy and curl among unmoving boulders. At the lower falls, the white water holds together, and is driven deep into the valley floor before it glides away from the base of the 2,400-foot cliff.

For many millenniums, the view of the cliff, the valley, and Yosemite Falls changed only slowly. And, until recently, the landscape remained much the same as it was at the time of the last glacial retreat. But during the last century, the minds and words of men have given the region the status of first a state park, then a national park; and within this time, the soft green valley at the foot of the waterfall has undergone more changes than at any time in the last ten thousand years.

Today the valley contains two asphalt roads, three hotels, hundreds of cabins, an outdoor amphitheater, two grocery stores, a hospital, seven souvenir stands, a laundry, three auto service stations—and not much grass. On any given weekend between June and September, row upon row of tents butt up against one another, suburban fashion, and upwards of 40,000 visitors swarm over the landscape. At several locations, parking lots sparkle as the sun plays on the skins of several thousand of Detroit's latest creations. Lines of automobile traffic clog the access roads, while hundreds of other motorists impatiently scout the park for a vacant parking space.

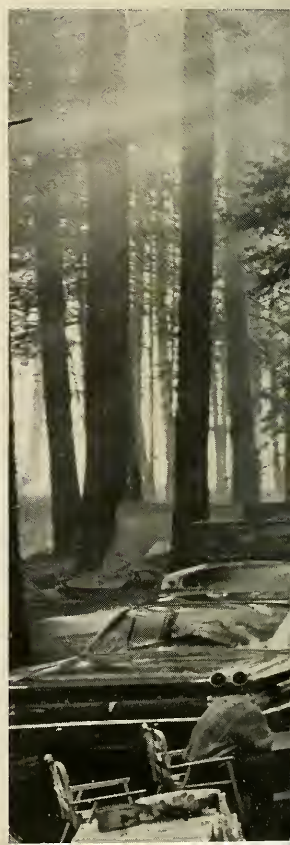
In the evening, a haze hangs over Yosemite; not the fragrant mist of a wilderness valley, but a heavy layer of campfire smoke and exhaust fumes. Many of the daytime visitors depart, and the sound of human voices lessens somewhat; but the clatter of pots and pans, the snarl of a motorcycle, and the cacophony of transistor radios rise to take its place. Along toward morning, after campers have gone to bed, the wind through the evergreens and the age-old roar of the waterfall again become audible.

When you first drive into the park, you wonder how the valley used to look. And if, by chance, you happen to know that the act of Congress which established the National Park Service in 1916 states that the environment of the parks is to be preserved "unimpaired for the enjoyment of future generations," it occurs to you how futile this legislative idealism has become in only fifty years. But no wonder, for the language of the act incorporates a basic contradiction — the incompatability between the concept of "unimpaired," and the swelling ranks of the "future generations," which have now arrived in full force. And while the Department of the Interior is fully aware of its schizoid mandate, no one, from Park Service Director George Hartzog to Secretary of the Interior Stewart L. Udall, has yet decided how to direct the conflicting policies it engenders.

Probably the language of the organic legislation didn't strike anyone as being contradictory in 1916, when the Park Service first opened its doors to the public. But the pc ulation of the United States in thc days was only 100 million, and that number, only 356,000 fou their way into the national parks.

For a number of reasons, pa visitation increased slowly during t System's first thirty years. Few pe ple owned automobiles and few still had the time (or courage) drive them to the western stat where many of the national par are located. Most of the populati lived in a rural setting, and even li in the big cities wasn't particular stifling. Air pollution was in its i

In summer, getting away from it all with a trip to the national parks becomes difficult, when several million others have the same idea.



'arks

by Jack Hope

fancy, and the traffic jam hadn't yet come into its own. There was abundant open space. Woodlands surrounding metropolitan areas hadn't been leveled for shoebox developments or sliced with highways, and except in urban areas, few industries had shoved their ways to the riverbanks and lakeshores as a means of solving their waste disposal problems. If you wanted a swim in a cool mountain brook, a hike through an evergreen forest, or just a few days of solitude, you could find them relatively nearby, if not in your own backyard. The need for park space did not seem urgent, and in 1940 only 17 million people visited the National Park System.

But coincident with the unprecedented increases in population, and the mobility and affluence of the postwar years, the flow of traffic into the parks underwent a sudden upturn, from 33 million in 1950 to 79 million in 1960 and finally to the current figure of about 145 million man-days spent in the national parks each year. And if park visitation continues its geometric rate of increase throughout the remainder of the century, then during every day of the four summer vacation months of the year 2000, there may be an average of something like ten people on each acre of the National Park System. So, if you're planning to spend some of your retirement years camping in the national parks—even if you plan to camp in what is today called the "back country"—perhaps you'd better make your reservations now.

When dealing with magnitudes like these, when facing up to the pressures created by a wealthy and rapidly expanding society, you suddenly realize that it becomes entirely legitimate to ask whether the Na-

tional Park System can survive prosperity.

Today, a typical visitor to the national parks has at least a two-week vacation and a total of almost four months of "off" time every year. He, along with 80 million others, owns an automobile, which in a matter of a few days can carry him over a series of superhighways to Yellowstone, Shenandoah, or any other park within the continental United States. He's probably saved enough to treat himself, his wife, and their 1.6 children to a trip of 2,000 miles, which may include several of the national parks. The cost of motel rooms may present something of a barrier, but if he owns a camp trailer or tent, he can cut expenses by staying overnight in a national park—provided he can find a vacant campsite.

If he is on vacation, trying, as many park visitors do, to see as many of the national parks as possible in a minimal period of time, his stay in each will be a short one—somewhere in the neighborhood of 36 hours. Of course, he can't get to see much of the park that way, nor can he get much of a feeling for the outdoors, other than what can be absorbed through the windshield of an automobile. But that's probably not the reason he came to the park in the first place, and so, like other visitors, he'll most likely spend 95 per cent of his time on less than 5 per cent of the total parkland—on the roadways and in the heavily developed and highly convenient areas surrounding the "visitor centers."

If you belong to this group of "windshield visitors," as Director Hartzog dubs them, your conception of the much talked about "park experience" might be typified by the remark of the well-dressed lady in Yellowstone's Old Faithful Inn who announced, as she sipped her gin and tonic, that she and her husband were "anxious to do the Tetons" before returning home to the East. "Do" in this case didn't include anything as rigorous as overnight camping, but then, most of the larger parks have hotel or motel accommodations, so probably her way of using the parks continued undisturbed.

Small wonder that those interested in the function of the parks worry over the nature of the benefits derived from a visit to the National Park System, for observation and

The automobile—a source of mobility and a cause for concrete

It's a little late for a park in muc[h] of California's redwood countr[y]

statistics indicate that the park experience has taken on many of the characteristics of a circus sideshow. A three-minute look at Old Faithful ("watch it steam and spout!") or a quick jaunt on a boardwalk above the Everglades alligators ("living monsters from another era!") and the hurrying visitor is off to see another "freak" of nature in a different park.

On the other hand, the tourists who never stray far from the visitor centers are indirectly performing a service for which many Park Service employees are grateful. For, by confining their activities to a small portion of the park, these visitors greatly simplify the task of safeguarding the true wilderness areas where relatively few people venture. But perhaps this situation engenders a false optimism, for as park visitation increases, even wilderness areas will be subjected to destructive pressures.

Although the park experience has not been officially defined, a notion of what it might ideally consist of can be derived from a speech given by Director Hartzog in which he expressed the opinion that the "single and abiding purpose" of the National Park System should be "to bring man and his environment into closer harmony." The Director described the parks as "places of highest inspiration," having "scientific, cultural, esthetic" and "educational" values. Yet, the lady "doing" the parks through the window of the cocktail lounge, the overnigh[t] camper seeking to escape the cost o[f] a motel room, and the weekendin[g] teen-ager who comes looking for age[-] mates and excitement somehow don'[t] fit into this mold. They use the park[s] for reasons unrelated or only vaguel[y] related to the richness of the natura[l] environment enclosed within thei[r] boundaries; and the activities the[y] pursue are largely those that coul[d] be performed elsewhere, with littl[e] loss to the pursuit, and with grea[t] benefit to the task of the Nationa[l] Park Service.

Which brings up the question, i[f] you happen to be concerned over th[e] welfare of the large natural parks, o[f] the proper use of a park and if some[-] how the "improper" uses couldn't b[e] screened out, without going so fa[r] as to administer lie-detector tests t[o] incoming visitors. But then you re[-] call that the National Park Servic[e] is a public-serving, self-perpetuatin[g] agency that depends, as all agencie[s] do, on congressional appropriations. And appropriations, by and large are dependent upon numbers—num[-] bers of visitors, buildings, highway[s] —easily counted physical numbers. Remembering this, it's easy to imag[-] ine that each year when the Directo[r] brings his case before the Bureau o[f] the Budget, he must be somewha[t] grateful that he has not guarded hi[s] gates too closely and that park visi[-] tation has risen over the precedin[g]

year. The National Park Service is already a low man on the totem pole of budgetary priorities. Would it enhance their competitive position against such pork-barreling giants as the Army Corps of Engineers to greet Congress with the message that: "Through the exclusion of visitors whose recreation could easily have been obtained outside the natural areas of the parks, and by our refusal to destroy any more parkland for construction of parking lots and access roads, we have reduced visits to the National Park System by 2 per cent"? Probably not.

Furthermore, the National Park Service is wedded to the philosophy that a visit to one of the country's areas of outstanding natural beauty is a right and not a privilege. Anyone who happens to have a $7 Golden Eagle pass can visit any park, any place, and can pursue almost any type of recreation; the Superintendent doesn't ask if you are going on a nature hike or whether you are going to play poker somewhere among the canvas and metal shelters of the public campground.

And so, while the Park Service may on the one hand be rightly concerned because the park experience may not foster an appreciation, or even an understanding, of the natural environment, their actions might at times lead you to believ otherwise. Their policy to date ha been one of accommodation; accom modation of rapidly increasing num bers of visitors, of automobiles camp trailers, and other gadgets tha the modern outdoorsman demand for "roughing it."

The meaning of *roughing it*, quit naturally, varies from park to park just as it differs among people. A Isle Royale, a roadless half-million acre island in Lake Superior, visite by only 13,000 persons per year, th practice probably embodies prett much of what George Hartzog woul describe as the "challenges and . . rewards" of the wilderness. Here, th challenge might be summed up a survival in an environment that ha not been hand tailored to minimiz the reality of the struggle for exist ence. The reward, in addition to th sounds, sights, and smells of wilder ness, might amount to the develop ment of a greater appreciation of th forces that have been shaping ma for the last 100,000 years, and per haps a heightened awareness of th shaping that he, in turn, has per formed during the last few centu ries. Then, too, there is the though that we most appreciate those thing for which we work hardest. And thi may well be the case at Isle Royal where the park experience is now pro vided along the guidelines mentione by the Director.

At any rate, a considerable numbe

Drainage canals near the Everglades destroy the national park, but they help the real estate business.

people feel that as many as pos- ile of the natural areas within the tem can be managed so as to ieve the "single and abiding pur- e" of building an awareness of natural environment—even in h heavily visited natural areas as semite and Yellowstone. They sus- t that the appropriate aim of the tional Park Service should be to ke the parks as *different* from the ban environment as possible, her than to provide the outdoors h "hot and cold running," and skeptical of the real value of the ght club entertainment, the $30 tel rooms, and the souvenir stands de available in the parks. And, king forward to the day when pulation has doubled or trebled 68 levels, they somehow feel that largest item in the Park Service's dget should not be "Construction, d Parkway and Road Construc- n" ($49.6 million in fiscal '68) t "Management and Protection" 40.7 million).

It may still be difficult to appreci- just how prosperity—that condi- n to which we ascribe magical alities—may have any sort of neg- ve consequences or how it may ve brought about deterioration of e park experience. For it is, in fact, e economic affluence of American ciety that has provided the time, oney, and mobility to make your sit to the parks possible. In essence. osperity has been a great source of

freedom, and more than likely, you are grateful for your two-week vacation, and for your high-speed automobile and the multilaned highways, which contribute to it.

But after a number of vacation visits to any of the more popular national parks, the realization is thrust upon you that the workings of the same set of social forces have simultaneously removed an equally large amount of freedom and that the evidence of deterioration is abundant. In Yosemite Valley you find, not a pleasant outdoor experience, but a transplantation of suburbia, with all the accompanying ills of smog, noise, crowding, and juvenile delinquency. At the Grand Tetons you are unable to find a free site in which to park your lovely new camp trailer. Throughout the million acres of Everglades National Park, you discover the flora and fauna dying as a result of nearby drainage canals built to accommodate agricultural and real estate development. And on a drive over the Blue Ridge Parkway, connecting Shenandoah and Great Smokies national parks, you are

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caught in a two-hour traffic jam that is no more enjoyable than one you could have experienced back home on the Long Island Expressway.

Delving into these few manifestations of deterioration leads to the unfortunate conclusion that most of the problems of the National Park Service have their origins outside the

oundaries of the park system. And lthough the problems may be al- viated (or compounded) by actions f the Service, the fact remains that ıey are equipped to deal only with ymptoms and not with basic causes.

If this were not the case, if the 'ark Service were ordered by Con- ress to deal directly with the causes f their current headaches, then robably they could begin by dis- ensing birth control pills at the main ates of each of the national parks. 3ut short of that, and lacking a pop- lar appreciation of the consequences f overpopulation, the National 'ark Service must direct its attention o the other end of the problem and ope that it can continue to acquire and in adequate amounts to keep ace with the demands of the spiral- ng number of park visitors.

For this purpose, Congress in 1964 stablished the Land and Water Con- ervation Fund, which, it was hoped, vould provide the primary source of unds from which new parklands ould be purchased. Money flowing nto this fund is derived in part from ees paid by the public for the priv- lege of using the recreation lands dministered by the federal govern- nent. These lands include not only ıational parks but reservoir projects dministered by the TVA, Army Corps of Engineers, Bureau of Rec- amation, and three other agencies. The only problem with the fund is hat it is inadequate. A recent study conducted by the Bureau of Outdoor Recreation concluded that in the next en years the fund will fall $2.7 bil- lion short of the financial require- ments for needed land. And other facts complicate the issue. At this writing, for instance, there is before Congress a bill that would relieve the Army Corps of Engineers of the responsibility of collecting user fees on the reservoir lands it administers.

Meantime, the price of land still available for inclusion within the National Park System continues to rise at something like 5 to 10 per cent per year. Since it takes Congress years to appropriate money for a park once a site has been recom- mended, land prices have a strange way of doubling and tripling in the time period prior to purchase. And, while Congress hesitates to purchase land that has undergone what Pres- ident Johnson calls "artificial price spirals," the prices continue to rise

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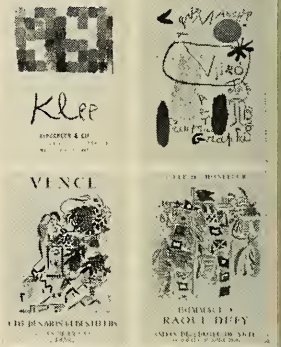

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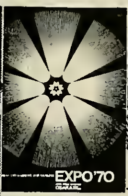

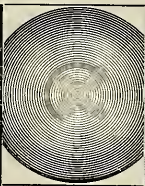

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and the region's suitability for national park status continues to decline as local interests hasten to make maximum use of the area's resources before the government finally takes possession.

With circumstances like these, it seems clear that potential parkland is now as inexpensive and pristine as it will ever be. But this fact has no apparent effect on the urgency with which Congress views the situation. The proposed Redwoods Park in California and Cascades Park in Washington, for instance, were suggested as national parks 50 years ago and 30 years ago, respectively, but have been ignored until recently when the aggressive campaigns of conservation groups brought the issues to the forefront.

At times, if you follow the disputes over establishment of new national parks, you wonder if perhaps the poor bargaining position of the National Park Service isn't a manifestation of something larger than price disputes. In the case of the Redwoods Park, for example, the Park Service in 1964 gave top priority to the Redwood Creek site after conducting a survey of possible park locations. Sometime later, however, after lumbermen had voiced opposition to the preservation of this area, Secretary Udall suddenly announced that he had decided instead to champion a park in the Mill Creek region, which had already been heavily cut over. In his explanation for the change of heart, Udall noted that he "wanted to pick a park, not a fight," which might make you wonder if the intention of the National Park Service to set aside the finest scenery for the benefit of the American people was being accorded a lower priority than the economic interests of West Coast lumber firms.

Udall's dislike of fighting apparently is not shared by either conservationists or lumber companies who now employ full-page newspaper ads to voice their opposing points of view in the bitter struggle over the redwoods. But while they battle to maintain a favorable public image, timber firms are still using their saws on the redwoods, pending a congressional decision on the boundaries of the proposed park.

There is an important instance of the Secretary changing his mind in an opposite direction. In 1965, the

U.S. Government Printing Office (whose expenses are borne by taxpayers) published thirty pages of glossy finished color photos and text advocating construction of two hydropower dams on the Colorado River. Marble Canyon and Bridge Canyon dams would be built by the Bureau of Reclamation as a money-making project, and would, as the book implied, provide the least expensive source of power for southwestern states. Among the points listed in favor of the dams was that the man-made lakes thus created would somehow "bring man a little closer to God."

For some reason, the book skimmed over the violent public opposition to inundation of 150 miles of the 10-million-year-old Colorado gorge and to impingement by one of the lakes on both Grand Canyon National Park and Grand Canyon National Monument. Alternative means of providing the power—nuclear or coal-driven plants—were regarded as "confused concepts." Written contributions to this unsubtle document were made by the Commissioner of the Bureau of Reclamation and by Secretary Udall.

After a prolonged and colorful battle, one seasoned group of conservationists proved, to the apparent satisfaction of the administration, that one of the confused concepts—coal-powered plants — could supply the needed power at less cost than could the hydro plants. Early in 1967, Secretary Udall agreed that perhaps the dams were not really necessary after all. The proposal was laid aside, to the relief of those who suspected right along that the man-made lakes might not, in fact, bring the nation any closer to God. (In all fairness, and using the common conception of God's geographical location, it should be admitted that a few waterskiers stood a chance of being brought closer to Him by about ninety feet—the distance by which the dam advocates wished to raise the level of the Colorado River.) In any event, if you are inclined to worry over the money we wasted in printing the hydropower propaganda, your concern is probably unfounded—the booklets will most likely be used when the proposal comes up again.

In this instance, a spectacular display of some of the world's oldest geology, including portions of two

units of the National Park System, escaped destruction by a hairbreadth, largely on the basis of that most potent of criteria—money. It makes you wonder if all irreplaceable resources will eventually be subjected to the test of the marketplace, as if they were refrigerators or automobiles. You may even question the claim to sophistication of a society that embraces materialism as the hallmark of the good life.

And perhaps you ponder the fate of the whole of the National Park System. How "inviolate" will be the boundaries of Rocky Mountain National Park if a rich oil-shale deposit is revealed to a nation of 400 million persons owning 300 million automobiles? To 600 million owning 450 million automobiles? Who will question commercial intrusion, providing a "need" for the oil can be established?

"Need" is a concept often employed in disputes over the national parks. You are told, for instance, that the 35,000 annual visitors to Mount McKinley in Alaska need a wider, straighter road to provide easy access to the park. (Director Hartzog has even advocated helicopters and "motor nature trails" as a means of access to the wilder areas of some parks.) The present road into the park, with minor modifications, is more than adequate to handle visitors, but is being widened regardless.

In ten years, when visitation at McKinley has expanded, largely as a *result* of the road, the statistical increase will be quoted to justify construction of new parking lots and mass camping facilities needed by the new visitors. And in twenty years, increased visitor density at the original visitor center and resulting damage to the landscape will dictate the need for a new road into another part of the park so that the camping pressure can be dispersed. And on and on, the "need process" repeats, not only within the parks but, to a much greater extent, in areas adjoining their boundaries.

Statistical "proof of need," for new highways, dams, power lines, mineral leases, grazing lands, parking lots, residential space, and farm land, is easy to come by. Each year the chambers of legislative committees are inundated with this "evidence" in attempts to obtain authorization for a variety of park-related projects that

nvolve substitution of man-made, nass-produced devices for portions of irreplaceable natural environment. 3ut each of these projects is underain by a value system, a set of asumptions seldom explored with the ame painstaking care with which congressmen scrutinize statistics. It night be worth restating the "need" nvolved in some of the more troubleome proposals that have faced the National Park System, in an attempt o provide a rough framework for consideration of such projects as will rise with increasing frequency in he future, and to strip away some of the superficiality that mere statisics sometimes imply. If you were to ndertake this project for one or two epresentative situations, your prosoectus might read as follows:

We feel the need for a drainage canal close to the boundary of Everglades Park, under the assumptions hat (1) the residences to be located on the land thereby reclaimed could not be situated elsewhere (as they can), (2) the speculative profits derived by local real estate firms outweigh the loss to the country as a whole of the consequent destruction of portions of the park, (3) the lives of any creatures thus destroyed are singularly unimportant, and (4) the ecology of regions surrounding naional parks can be disregarded insofar as protection of the park is concerned; or, in a more general sense: We propose that cutting of timber be permitted in Olympic National Park, based upon the beliefs (1) that the proliferation of material objects thus created is of greater value to the American civilization than are any of the esthetic and nonmaterial contributions of the natural environment, (2) that the mere fact that the country is endowed with a rich environment dictates that resources shall be exploited to the fullest, and (3) that derived economic gains shall be transformed into additional population growth, which in turn will justify further exploitation.

Somehow it sounds different this way.

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A Naturalist at Large

Effluents of Affluence

by Marston Bates

"When some future historian shall sit down to summarize what the present generation of Americans has accomplished, his climactic sentence could read, 'Of the waters, they made a cesspool; of the air, a depository for poisons; and of the good earth itself, a dump where rats nuzzled in piles of refuse.' "

With these words George Stewart starts his new book, *Not So Rich As You Think*. He goes on to speculate about the need for some one word for all of the miscellaneous effluents of our affluent society. "There does not exist in English—and perhaps not in any other language—any single traditional term covering the whole conception. Instead we all know a host of more or less specific terms—*sewage, garbage, junk, litter, smog, refuse, waste, offal, slops, pollutants, rubbish, trash*. . . . Perhaps the nearest to universality is *crud*, that coinage of the G.I.'s of World War II. But that term is now old-fashioned slang, and in many people's minds approaches being an obscenity."

It is crud, all right, and why not call it that? Stewart's book, published in January by Houghton Mifflin (and aptly illustrated with drawings by Robert Osborn), forms an excellent survey of contemporary American crud production. A fine companion volume, *The Frail Ocean* by Wesley Marx, published last October by Coward-McCann, takes up the problems of the crud that is accumulating in the seas—which we blissfully regard as the perfect dumping ground because the stuff is at least hidden under the waves and out of our sight.

Stewart suggests that human messiness comes in part at least from our simian ancestry ("Monkeys cannot be housebroken"). Birds and arboreal mammals can quite simply drop things with the assurance that they are thus removed from the environment. Birds keep their nests clean, but our nest-building ape cousins don't even bother with that. George Schaller, in his well-known study of *The Mountain Gorilla* (University of Chicago Press, 1963), reports on the examination of 2,451 gorilla nests (they are built anew each night). He found dung in 99 per cent of the nests. If this is our background, it is no wonder that we are careless.

We do usually manage to housebreak our children—though some psychologists seem to think we may damage personalities in the process—but the history of human crud disposal is not reassuring. I wonder about those australopithecine cave inhabitants of South Africa. They had come down out of the trees, but it doesn't look as though they had acquired tidy habits. The human fossils are found together with thousands of animal bone fragments—apparently leftovers from food, though Raymond Dart thinks that many bones were used for tools. But what about the australopithecines themselves? Were corpses allowed to rot where they fell? The caves must have been pretty foul-smelling places. When we do find evidence of burial, as with the Neanderthal men, it seems to have been for religious rather than sanitary reasons.

Then came the development of agriculture and the possibility of settled village life—the period known to anthropologists as the Neolithic. "Neolithic man," Stewart observes, "having invented living in permanen

villages and keeping cows and sheep, immediately faced a disposal problem. This was one price of his advance toward civilization. Apparently he solved this problem by generally ignoring it." This, of course, was a help to future archeologists, because they could learn much about ways of life from the study of kitchen middens—the polite term for ancient garbage dumps. Peasant peoples to this day often live with their animals in a welter of manure and refuse: I remember thinking, when living in Egypt, that the accumulated debris made the average village look as though it had recently suffered a bombing raid.

New disposal problems arose with the concentration of people in cities. Some cities, like those of the Indus Valley, Mesopotamia, and Crete, had marvelously constructed sewers and drains; but others must have been extraordinarily filthy. The seven cities at the site of Troy are a case in point—each city built on the debris of its predecessor. The people seemingly never bothered to clear anything away. And so the history continues through the notorious slops and filth of medieval cities.

It seems, then, that man has long lived with his own crud. There are, of course, many shining exceptions—I remember vividly the neatness and cleanliness of the un-Westernized Micronesians on Ifaluk, where I spent part of 1953. But they had the lagoons easily available for bathing and for dumping; and their dumping was too limited to cause any pollution problem. There were no tin cans, no bottles, no paper.

If most men have been living in

their own fouled nests for so long, what is all the fuss about now? There is, in the first place, a matter of sheer quantity. The exploding human numbers result in a corresponding explosion of human waste products. Furthermore, in the United States at least, there is a clear tendency toward increase in the amount of crud per person. In *Man on Earth* (Sausalito: Contact Editions, 1962) S.P.R. Charter notes that "In 1940 the people of the United States accumulated an average of two pounds of garbage per person per day for a national total of some 50 million tons a year. Twenty years later, in 1960, the garbage averaged a little more than 3.5 lbs. per person per day, for a national total of some 115 tons a year." I don't know where Charter got his figures. but they sound reasonable.

Stewart lists three other basic causes of the present crisis: the growth of cities, the development of the "affluent society," and the invention of synthetic technology. Nine out of ten Americans now live in cities, whereas in the not distant past most were rural, living on farms. On the old-fashioned farm waste disposal could safely be left to the individual or the family: garbage buried, manure used to fertilize the fields. The city dweller has no way of disposing of his own waste; there must be some public means of collection and disposal. which generally means taxes unwillingly paid and usually inadequate.

One characteristic of our affluence, of course, is that things are often thrown away to be replaced by new, instead of being repaired—in our economy replacing is often cheaper than repairing, at least in the short run. And no one seems to worry about the long-term costs. We also rarely recycle materials; they are used and then dispersed. The junkman has come to represent a rare and not highly respected profession, though in a thrifty economy he would be very important. As Stewart remarks, "Don't shoot the secondary materials man."

We are all aware of the industrial wastes that pollute water and air, though there is little agreement about what to do about them. The synthetic technology, in addition to wastes, turns out a variety of products that are difficult to get rid of. Plastics, for instance. They don't rot or rust, and burn only with a very hot flame. Like glass, the plastics will stay with us to help future archeologists investigating our culture; the plastics don't even break so that they can be converted into pretty pebbles by the pounding surf, as is the case with glass. And then there is the problem of the highly dangerous crud produced by nuclear reactors.

Stewart sometimes sounds as though our crud problems would be solved if we could get the stuff to the ocean; but Wesley Marx points out the dangers there. We tend still to think in terms of Lord Byron's well-known lines:

> Roll on, thou deep and dark blue
> ocean—roll!
> Ten thousand fleets sweep over
> thee in vain;
> Man marks the earth with ruin—
> his control
> Stops with the shore. . . .

But this is no longer true. Even the oceans falter with the load of man's accumulating crud. "Fish stocks can be depleted. The nurseries of marine life can be buried. Beaches can erode away. Seawater, the most common substance on this earth and the most life nourishing—at once liquid soil and liquid atmosphere—can be hideously corrupted. It can host substances that in the stomachs of oysters or clams are refined into poisons that paralyze porpoise and man alike."

The stories told by Stewart and Marx are dismal indeed. Even more dismal is the fact that in general we know what we are doing, and in many cases have the knowledge and ability to correct our actions, but we are unwilling to spend the money and the effort until events reach crisis proportions, when it may be too late. We are running up a tremendous bill that must be paid by our descendants —"we are not so rich as you think." Solutions, also, often require governmental or regional planning and action: the "government interference" that is viewed so dimly in the American tradition. In the case of the sea international planning is urgently needed, and the control of marine resources might, quite logically, be a function of the United Nations.

It is difficult to be cheerful about the human animal when we look at his resource management or his methods of disposing of things.

ETHIOPIA

by Alan Ternes

At the turn of the century the French geographer Paul Vidal de la Blache developed the concept of *possibilisme* to explain the relationships between human activity and environment: given the physical and biological elements of a region, man has a limited number of choices for development.

The concept of possibilism has been revised, rejected, and even ridiculed by many modern geographers because it has little apparent validity in an industrialized, urbanized society, which can make its own climate, can cut through or fly over mountains, and seemingly can trample and ignore its biota.

But possibilism remains a useful lens for viewing many less developed regions, and this is especially true for Ethiopia, an isolated empire in the northern highlands of East Africa.

At first glance, a traveler to Ethiopia today will see a veneer of modernity. The jets of Ethiopian Air Lines land at the up-to-date airport of Addis Ababa, the nation's capital. A divided four-lane highway leads past contemporary government and office buildings to posh hotels with all the comforts and frills of hotels in any major European or American city. On the highways new, huge Italian diesel trucks with tandem trailers roar by. Drugstores, department stores—even ice-cream parlors—sell the sophisticated products of Western society.

But a second glance, even in the capital city, reveals customs and costumes that make the nation's tradition-bound Coptic Church, founded in the fourth century, seem almost modern. In a field beside the airport a farmer behind two trodding oxen toils with a single-pointed wooden plow that, except for its iron point, is similar to plows used in the Nile Valley for millenniums. Dressed in handwoven brown robes and animal skins, shepherds who have walked for days from distant mountainsides drive goats and cattle through the streets to market. At many corners farmers squat beside a few eggs and thin chickens in wicker cages and barter for other goods, for bars of salt (an ancient currency still common throughout the country) or, occasionally, for money. These Ethiopians of the countryside and villages—the 90 per cent of the population that survives mainly on subsistence agriculture—live under a strict regime of possibilism, as their forefathers did, as men in the Ethiopian highlands have done for thousands of years, possibly since the beginnings of civilized man. From prehistory to present the environment has

A highland valley south of Aksum bursts into a profusion of yellow flowers, called noug, at the end of the rainy season in September. The 13,000-foot-high Simien Mountains are silhouetted on the skyline.

South of Lake Tana, the Blue Nile roars over the Tis Abbai Falls.

On foot: the common mode of transportation for both men and animals. Ethiopians, who often walk long distances, carry ever-present hardwood staffs, formerly for protection, but now more by habit and custom.

A woman in a Moslem-influenced costume readies her produce for a day of trading.

imited economic activity and has greatly influenced ultural development. Often parts of the environment iave served as barriers against the movement of men, of goods, and of ideas.

The most obvious environmental barrier in Ethiopia is the rugged land, which ranges from below-sea-level deserts to 15,000-foot jagged mountains that create some of the most striking landscapes in Africa.

Ethiopia has two broad highland, or massif, regions: the Ethiopian Plateau in the central and northern part of the country, and the smaller Somali Plateau in the southeast. They are separated by the Great Rift Valley.

The two plateaus are geologically young tablelands, uplifted in the mid-Pleistocene period. From the air and on topographical maps the evenness of the plateaus is evident, but on the ground the view is different. A British soldier on the Napier military expedition a hundred years ago wrote, "They tell us this is a table land. If it is, they have turned the table upside down and we are scrambling up and down the legs."

The flat areas of the plateaus, which average about 8,000 feet high, are called *ambas*. These plains have some of the best soils in Africa; they are well watered, and support most of the Ethiopian population at densities of up to 200 persons per square mile. The fertile plains were nearly totally deforested long ago, and today they are used mainly for growing grains and cattle grazing.

Nile tributaries and other rivers have cut deep, steep-walled gorges in the Ethiopian Plateau. Some of the gorges plunge downward for more than a mile, and like the Grand Canyon of the United States, you often approach them unknowingly across a level plain. Suddenly, the earth seems to fall away, revealing an immense, lush green valley. Thin ribbons of water cascade down the sheer walls to join the river, which, from the mile-high bird's-eye view at the edge of the plateau, appears to be small and hardly capable of sculpturing such a vastness. The walls of the valley, which are too steep for farming, are lined with deep-green natural vegetation, except where rock formations, red and pink from tropical weathering, outcrop. Clouds drift off the highland plains and lower a misty veil over the curving sides of the upper valley, creating the mysterious atmosphere typical of an oriental painting.

The rivers on these plateaus are geologically young, and because of the height and press of water during the rainy seasons, they have knifed into the land, creating many rapids and falls. These waterways cannot function as transportation arteries and have always been major barriers to man. Many *ambas* have been practically isolated by them from other parts of Ethiopia.

The Great Rift Valley, one of the most remarkable geomorphological features in the world, divides the two plateaus of Ethiopia. It was formed by the downfaulting of massive blocks of the earth's surface, while on both sides the giant plateaus thrust upward.

Beginning at the Red Sea coast of Ethiopia, where it is more than 200 miles wide, the Rift Valley narrows as it moves to the southwest and then splits into segments as it extends southward through most of the African continent. At some places the irregular

escarpment rises more than two miles above the level floor of the valley. Long, narrow lakes, savanna, grasslands, and deserts occupy parts of the Rift Valley. The great tectonic forces that shaped this region also unleashed much volcanic activity, causing conical volcanoes and black lava fields to protrude at many places on the valley floor. The harsh deserts of the Rift Valley, combined with fields of jagged lava and the towering escarpment, are strong barriers along the eastern side of the Ethiopian Plateau, and serve to isolate the highland area from the Red Sea.

The gigantic landforms of Ethiopia strongly influence two factors of climate: temperature and rainfall. These factors, along with soils and slope, are fundamental to agricultural productivity, and so have a pronounced effect on the country's economy.

Ethiopia is just north of the Equator, ranging from about latitude 3 degrees to 18 degrees north. The whole country falls within the equatorial zone, but

A tree with thorns for protection against browsing animals rises above the grasslands of the Rift Valley.

most of the areas do not have tropical temperatures.

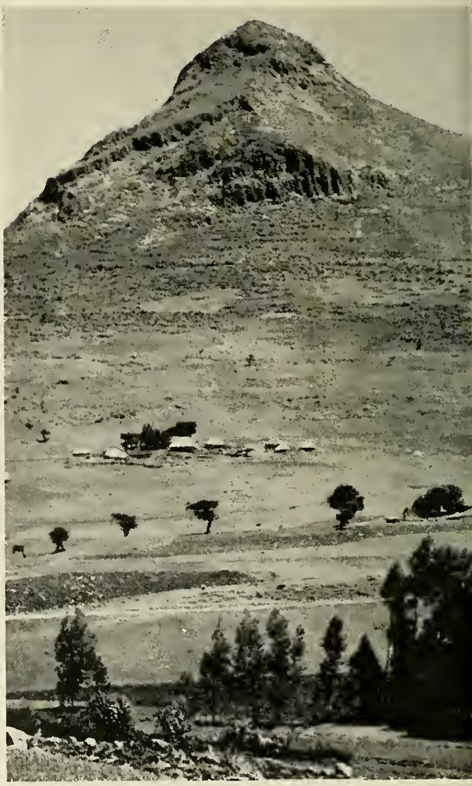
Some areas are hot: in the Rift Valley, the Danakil Depression, which drops to 380 feet below sea level, would rank among the hottest places in the world if reliable temperatures were recorded; and Gambela, in the rain forests of Ilubabor Province, fits the stereotype of a hot, humid jungle town. But the high plateaus are cool, even cold, with hail and near-freezing temperatures reported. Because temperature falls at the normal lapse rate of 3.6 degrees Fahrenheit for every 1,000-foot rise in elevation, temperatures of the Ethiopian highlands are some 20 to 50 degrees cooler than the tropical lowlands; or, to put it in other terms, the Ethiopian temperatures at an elevation of 10,000 feet are equivalent to the temperatures of a seaport 2,000 miles farther north. The average July temperature at Addis Ababa is 59 degrees, which is 15 degrees cooler than New York City's average July temperature.

The marked change in temperature at different elevations is quickly felt in the deep river gorges. From the edge of the plateau, with the temperature in the 50's and a brisk wind cutting through a heavy jacket, a traveler passes in minutes down a zigzagging road into the humid tropics, where thick stands of bamboo and large-leafed evergreen plants line the river. Often a cluster of women at the bridge will offer to sell baskets of tropical fruits: tiny bananas, oranges, and papayas, all grown nearby. Sheltered from any breeze, the heat and accompanying flurry of insects is oppressive. The engine of the automobile threatens to overheat as it climbs in low gear up the twisting road out of the valley. The vegetation changes, temperate trees replacing the tropical species. At the top a cool breeze sweeps away the discomfort, creating an effect similar to that of stepping into an air-conditioned store on a hot summer day.

Since antiquity Ethiopians have recognized three climatic regimes based primarily on altitude: the *quolla* (from sea level to about 5,000 feet); the *woina dega* (about 5,000 feet to 8,000 feet); and the *dega* (about 8,000 feet and higher). Most Ethiopians live in the middle category.

Although agriculture is primarily for subsistence, the differences in altitude do lead to some specialization and trading. The farmers in the *quolla,* for example, grow peppers and tomatoes and trade them for grain grown on farms in the *woina dega* and *dega.*

The highlands also cause abundant rainfall throughout much of the country. While most of the



Deforestation and overgrazing have cleared most highland areas, including this plain south of Gondar.

Pulled by oxen, an ancient type of single-pointed plow turns over the rich soil of a farm south of Addis Ababa.

surrounding lowlands have less than 10 inches of rain a year (barely enough to maintain small herds of cattle kept by nomadic tribes), nearly all the highlands have at least 40 inches of rain, and some have 75 inches. The country's rainfall comes mostly from the Atlantic Ocean. The moist maritime air passes across the continent until it strikes the highlands, rises and cools, and drops orographic rainfall.

The heaviest rains occur from June to the end of September, and this cloudy, damp period is considered winter in Ethiopia. The traditional winter period in other parts of the Northern Hemisphere marks the Ethiopian summer, which begins with festivals and blooming flowers in September and October, followed by warm, sunny days from November to January. The lack of freezing temperatures permits farmers to grow two or three crops a year.

The ruggedness of the land and the extremes of temperature and rainfall are dominant physical factors that are ever-present in the lives of Ethiopians. Any attempt to explain or understand their culture, history, and economy should weigh constantly the impact of these factors.

The prehistory of Ethiopia—in fact, of Africa—is a puzzle that may never be solved because warm temperatures and rains have destroyed most of the traces of man's activities. The principal discoveries of Stone Age man, including Dr. L.S.B. Leakey's findings in Olduvai Gorge, have been made in Rift Valley areas south of Ethiopia, and intensive investigation probably would turn up similar traces in some areas of Ethiopia.

"Men of science today are, with few exceptions, satisfied that Africa was the birthplace of man himself and that for many hundreds of centuries thereafter Africa was in the forefront of all world progress," Dr. Leakey said during a lecture at Oxford University.

Fluvial deposits in Ethiopia and the Sudan indicate that at least three major periods of heavy rainfall occurred in East Africa during the Late Pleistocene. At that time part of the Sahara and desert regions around Ethiopia today had flora and fauna of a moist climate and contained local Neolithic cultures. During these cold, pluvial periods the mountains of Ethiopia harbored many glaciers; vegetation changed to boreal species, and man probably did not inhabit the highlands. Between the wet periods were dry phases when the deserts expanded, driving man into the Nile Valley and, presumably, into the highlands. Evidence of these periods is scanty, but apparently the highlands of Africa acted as a refuge and, at times, a highway for the migration of man, other fauna, and flora.

The Blue Nile persisted throughout the dry periods of the Pleistocene, and its fertile, green, snakelike valley amid the brown sands of the Sahara was a constant link between Ethiopia and Egypt, just as it is today. Thus, man would have been able to migrate across the Sahara even during the driest periods. During the pluvial periods the annual flood was much

greater than it is today, and Lake Tana in Ethiopia, the headwater of the Blue Nile, was much larger.

Ethiopia today is a living museum of human groups, and probably some of the most fruitful studies of the origins and migrations of African peoples will be made there in the coming decades. This is largely a result of the numerous physical barriers that have permitted a large proportion of the population to survive in isolated pockets.

The relatively recent expansion of the aggressive Bantu groups, which absorbed or eliminated many peoples of East and South Africa, halted at the arid region south of Ethiopia's border. Similarly, the Nilo-Hamites and Nilotes, who began their expansion toward Ethiopia sometime after A.D.1000, stopped their migrations near the southwestern border.

As a result, one of the few Negro groups in eastern Africa survives near the Baro River in southwestern Ethiopia. A smaller group of forest hunters, called the Watta, is found in parts of southern Ethiopia. According to local legend, these forest people, who are about four feet tall, were the original inhabitants of the country. Even among the Hamitic-Semitic peoples, who are the majority in Ethiopia, differences of language and culture are evident. These differences reflect different waves of migration into the region from Arabia long ago, possibly beginning in Upper Paleolithic times.

The road from Asmara to its seaport of Massawa zigzags down the escarpment of the Rift Valley. Cacti are abundant in the arid region, and their red fruits are sold in highland markets.

The Blue Nile and its deep gorge divided and isolated two major parts of the Ethiopian Plateau— until the river was finally bridged.

The early recorded history of Ethiopia is an odd mixture of fact and fancy. The Greeks referred to the unknown region south of Egypt as Ethiopia, and Homer called the Ethiopians the highest of men, those who dined with the gods. The Bible tells of the Queen of Sheba, who journeyed from either Ethiopia or southern Arabia to Jerusalem to test the wisdom of King Solomon. The wise king answered all her questions, convincing the queen of his " . . . judgment and justice. And she gave the king an hundred and twenty talents of gold, and of spices very great store, and precious stones: there came no more such abundance of spices as these which the queen of Sheba gave to king Solomon. . . . And king Solomon gave unto the queen of Sheba all her desire, whatsoever she asked, beside that which Solomon gave her of his royal bounty" (I Kings 10:9-10).

Ethiopians believe that from her union with King Solomon the queen bore a son, Menelik, who went to Aksum and became the first emperor of Ethiopia. Many subsequent emperors, including Emperor Haile Selassie today, have claimed direct descent from King Solomon.

The mists of time hide the truth behind the Queen of Sheba and Emperor Menelik legends, but history shows that the town of Aksum in northern Ethiopia did become the seat of a great empire. The known history of the country begins with the rise of the Axumite Empire, which reached its highest glory and power in the early centuries of the Christian Era.

Within the past 2,000 years, Ethiopian rulers have risen and fallen and great wars of religion have been waged. But this country alone among African nations has maintained its independence. This fact, among others of Ethiopian history, reveals the imprint of jagged mountains, of deep gorges cut by rushing rivers, of cool green plains and burning deserts.

This article will be continued next month. It will discuss modern history, the people today, and efforts to bring Ethiopia into the twentieth century.

The Hunt of the Wasps

The natural history of Jackson Hole, Wyoming, is likely to bring to mind such things as moose and elk, eagles and osprey—and well it may, for there are few places in North America where one can see these great mammals and birds in such numbers. But the dominant creatures here, as everywhere else on land, are the insects. The short summers are alive with the hum and clatter of their wings, the pricks and barbs of their bites and stings. While the average visitor may not appreciate having his vacation punctuated by quite so many "bugs," the more astute is likely to feel that the sight of a *Parnassius* butterfly crossing a meadow of lupine is more than enough to forgive the insects their transgressions. He is likely to appreciate, too, that nature is all of a piece; that, in Francis Thompson's words, "Thou canst not touch a flower/Without the troubling of a star."

For a number of years I have been studying the digger wasps that thrive in small tracts of sand left here and there where the Snake River has cut away a bank and sorted and piled the sand on the inside of a meander. More than one hundred species of wasps occur in such areas—a remarkable mixture of species of northern and western origin, and even some eastern forms that have spilled over the divide and a few Great Basin species that have worked their way up the Snake. There are many ground-nesting bees here, too, as well as an assortment of other insects. The bees exploit the vast numbers of wildflowers that fill the great valley between the Tetons and the Gros Ventres, while the wasps hunt for spiders or insects to provision their nests. Each kind of wasp is quite specific in the type of prey it takes; collectively, the wasps prey on most of the more common insects of the area, but each takes only his particular "slice of pie." Thus, *Ammophila* takes leaf-feeding caterpillars, and *Stenodynerus* extracts small grubs and caterpillars from leaf mines; *Tachysphex* takes small, short-horned grasshoppers and *Palmodes* large, long-horned grasshoppers; *Bembix* takes large flies, *Oxybelus* small flies. Of the more than a hundred species, no two (so far as known) prey on quite the same thing in quite the same way. It is an apparently amicable, prosperous community of small creatures taking advantage of nature's bounty.

But of course nature is never quite that simple. A host of parasites inhabit these same sandy plots and thrive at the expense of the wasps and bees: such things as bee flies and small, inquiline flesh flies; cuckoo wasps and various cleptoparasites (thief-parasites) closely related to the bees and wasps they attack. Then there are wasps that prey upon the bees—no less than five species of *Philanthus*, the genus of the "bee wolves." There is a tiny species of *Philanthus* that preys on tiny bees, a slightly larger one that preys on slightly larger bees, and so on up to *Philanthus bicinctus*, a large and brilliantly colored species that is a specialist on bumblebees. And, to make the story complete, there are wasps that prey on other wasps. There are none, as a matter of fact, that restrict their attacks to wasps, but four of the five species of *Philanthus* sometimes take wasps instead of bees, and two of them take large numbers of wasps—often the very species that nest beside them in supposed amity. These two species are among the commonest wasps in Jackson Hole, and they evidently do a thriving business eating their neighbors, or, more exactly, serving them to their children, for adult wasps themselves feed innocently at the nectar of flowers. The use of wasps by bee wolves of the genus *Philanthus* is by no means unknown, but I know of no species that use them in such numbers as these.

During the summer of 1967, *Philanthus zebratus nitens* was unusually abundant, and I had an opportunity to observe an aggregation of three or four hundred females nesting in a sandy road in a delightful spot along the Snake River opposite the high peaks of the Tetons. When my family and I first discovered the wasps, about 9:30 on a morning in late July, each female was working at her nest entrance, clearing sand from the burrow and piling it in a fan-shaped or irregular heap with quick thrusts of the front legs. Then, one by one, they turned around and closed the entrance and flew off to a nearby clump of wild buckwheat, where they probed the flowers for nectar. Soon all were gone from the nesting area, and one would never have guessed that he was in the midst of such an aggregation.

Beginning at about 10:30, they began to return—but in a most dramatic manner. Each bore a relatively large, paralyzed bee or wasp beneath her—for *zebratus nitens* is a fairly large digger wasp, slightly more than half an inch in length—grasping it tightly with her legs and often also holding a leg or antenna in her mandibles. Flying high in the air, well above our heads, each digger wasp entered the nesting area, and then dropped suddenly, with an audible "plop," not far from her nest. Wasps

at Jackson Hole

by Howard E. Evans

laden with prey were soon dropping like large hailstones on all sides of us. Often a wasp would sit on the ground for some time, straddling her prey, as though recuperating from the sudden blow of landing. In fact, we found one that appeared to have knocked herself out from the impact; she recovered slowly in my hand and eventually flew away. After a short delay, each female proceeded to her nest entrance, at this time shifting her grasp so that she held the prey only with her middle legs; this left her front legs free, enabling her to scrape open the nest entrance and carry the prey directly in. After a minute or two in the nest, she emerged and took off on another hunting flight. One female brought in three large prey in half an hour.

This ritual was often complicated by the presence of parasitic flies that trailed prey-laden wasps and attempted to deposit their larvae on the prey. Such flies attack many different digger wasps, and in the nest cells their larvae destroy both the wasp's egg and the prey that was intended for the digger wasp's young. *Philanthus zebratus nitens* reacts strongly to the presence of these flies, and when followed by one or more the wasp takes off in a low, irregular flight, often buzzing loudly. She attempts to lead the fly away from her nest, landing here and there and sometimes traveling several yards before suddenly zooming back to her nest, often without the parasite. Sometimes a wasp will rise high in the air, then once again descend suddenly; this is a more effective way of losing the flies, which usually remain close to the ground. Since we later found maggots of these flies in very few of the nest cells we assume that these devious flight patterns effectively reduce the success of the parasites.

We visited the colony several times, and found that the same nests persisted for many days, eventually coming to contain fifteen or more cells. Each burrow descended at about a 45 degree angle, often with several turns, and the first cells were constructed at a distance of six to ten inches from the entrance. The burrow was extended a few inches each day, and additional cells were constructed from short side-burrows progressively farther from the entrance. Since the burrow tended to level off, all the cells were no more than five to seven inches deep, although the last cells in the nest were sometimes nearly a yard from the entrance. Each cell contained paralyzed prey, anywhere from three large bees or wasps up to nine smaller ones, the digger wasp's egg being laid on the last victim placed in the cell. After an incubation period of only two days, the larva emerged and within a week had grown to full size at the expense of the paralyzed prey in the cell. Then it spun an elongate, slightly tapered cocoon, in which to spend the next eleven months.

We were fascinated by the great numbers of large bees and wasps captured by *Philanthus*. Bees, largely leaf-cutters, made up somewhat more than half the prey. Of the wasps, male ichneumons of several species were most prevalent. However, *Ammophila azteca*, a wasp longer but more slender than *Philanthus*, which nested along the very same sandy road, was often used as prey—both males and females. We did not discover where the *Philanthus* were taking their prey. Presumably they captured them on flowers as other members of this genus are known to do. Many of these same bees and wasps were common on wild buckwheat, yampa, and other wildflowers growing in the vicinity.

One wasp captured in considerable numbers was *Aphilanthops subfrigidus*, which also nested in the same sandy road, preying upon queen ants in their nuptial flights. Of all the genera of digger wasps, *Aphilanthops* is most closely related to *Philanthus;* in fact, the two genera are difficult to tell apart in the field. Yet *zebratus nitens* used them in numbers—although never using members of its own species or any of the several other species of *Philanthus* (two of which were common in this area). Is *Philanthus* able to discriminate its own genus from among various digger wasps, some of them very similar in size, color, and structure? If so, is it by sight or by odor or by some behavioral cue? Dr. Werner Rathmayer of the University of Frankfurt found that the European bee wolf is immune to its own venom, the toxicity being destroyed by a substance in its blood. Is it possible that *Philanthus zebratus nitens* does sometimes attack members of its own genus, but that they simply don't succumb? This would seem a pretty inefficient procedure. It seems more likely that the various species of the genus *Philanthus* have learned to "identify" and to avoid other species of this genus.

There is a great deal still to be learned about the wasp-hunting wasps of Jackson Hole. Fortunately, they thrive in an area that has been consecrated to the study and enjoyment of natural communities, and there is hope that we may someday know these colorful and exciting insects much better.

SKY REPORTER

Every day at 1:00 P.M. a group of Harvard astronomers sends a message to a satellite 350 miles above the earth, giving it instructions for the next 24 hours. Every day an instrument aboard the satellite sends back 150 unique pictures of the sun, giving astronomers information never before available.

The Harvard device is designed to perform either of two operations: it can concentrate on one spot in the center of the solar disk and record the intensity of radiation over the entire ultraviolet spectrum, or it can scan the entire surface at any of about 50 wavelengths.

The light from ultraviolet wavelengths (which dissipate in the earth's upper atmosphere without ever reaching the earth's surface) is used to take the pictures.

Physicists know from the laboratory and from theoretical considerations that atoms of various elements, raised to certain temperatures, emit characteristic wavelengths of ultraviolet light. Detection of the ultraviolet wavelengths from different layers of the sun's atmosphere then reveals what elements and what conditions prevail in those layers.

The Harvard group is paying particular attention to solar flares—sudden great outbursts associated with sunspot groups, which pour streams of lethal radiation into space. These in turn cause magnetic storms on earth.

Between flares, the group studies each of the sun's 50 available ultraviolet wavelengths. Whatever modifications their work eventually leads to in our theory of the sun will also modify our ideas of the origin and evolution of the sun—and all stars similar to it.

AUTOMATION IN THE OBSERVATORY

The astronomer of the future may never know what it's like to huddle against the night's chill in a mountaintop observatory. He may instead sit in his shirtsleeves, surrounded by creature comforts, occasionally twisting a dial and periodically gathering the data spewed out by a high-speed printer.

Automation has come to the observatory, apparently successfully. This is the report in the journal *Science* from Stephen P. Maran, astronomer-in-charge of the 50-inch remotely controlled telescope at Kitt Peak National Observatory near Tucson, Arizona.

Co-ordinates for a star are fed into the computer at Tucson. The computer checks a sidereal clock to see if the star is favorably placed and checks with an automatic weather station at the telescope site. It will not move the telescope if something is wrong.

But if all is well, the telescope swings into the position programmed at Tucson. In the final stage of aiming, a photoelectric device locks onto the star and takes over. At the same time the dome swings around and the shutter opens to the necessary degree.

An alumnus of the Amateur Astronomers Association, a New York group that meets at The American Museum of Natural History, Maran, at a lecture last year, awed his former colleagues with movies of the unmanned telescope swinging obediently into place at the command of an operator 50 miles away.

In his *Science* article, Maran suggests a number of advantages for automated instruments. In one program being carried out at the New Mexico field station of Northwestern University, a group of astronomers is monitoring galaxies in a search for supernovae.

Their automated instrument projects the image of a galaxy onto a television monitor screen. Next to it a "control" image of the galaxy, previously obtained, is projected. The idea is to detect a supernova as early as possible so that photoelectric and spectroscopic data can be obtained during its initial stages. At present most such outbursts are discovered only long after the fact through a comparison of photographic plates.

Maran suggests that other uses to which automated telescopes may be put include: studies of small amplitude, short-period variables; photoelectric surveys of selected areas to give accurate magnitudes; and standard observations used in conjunction with larger instruments.

X-RAY STARS

Five years ago a group of astronomers sent a package of delicate instruments on a rocket flight hoping to find what they expected to be very faint X-ray emissions from outside the solar system.

They found more than they bargained for: X-ray sources a million times stronger than their predictions. Since then, some 30 strong sources have been found on a dozen rocket flights, leaving astronomers the problem of explaining them.

One theory involves close binary systems. It envisions an explosion on one of the stars resulting in a stream of hot, charged particles falling into the other. The energy of the impact of these particles with particles on the surface of the second star would be released as X-rays.

This explanation was first proposed by Iosif Shklovskii of the Soviet Union. It was amplified at a recent New York symposium by Kevin Prendergast, a Columbia University astrophysicist.

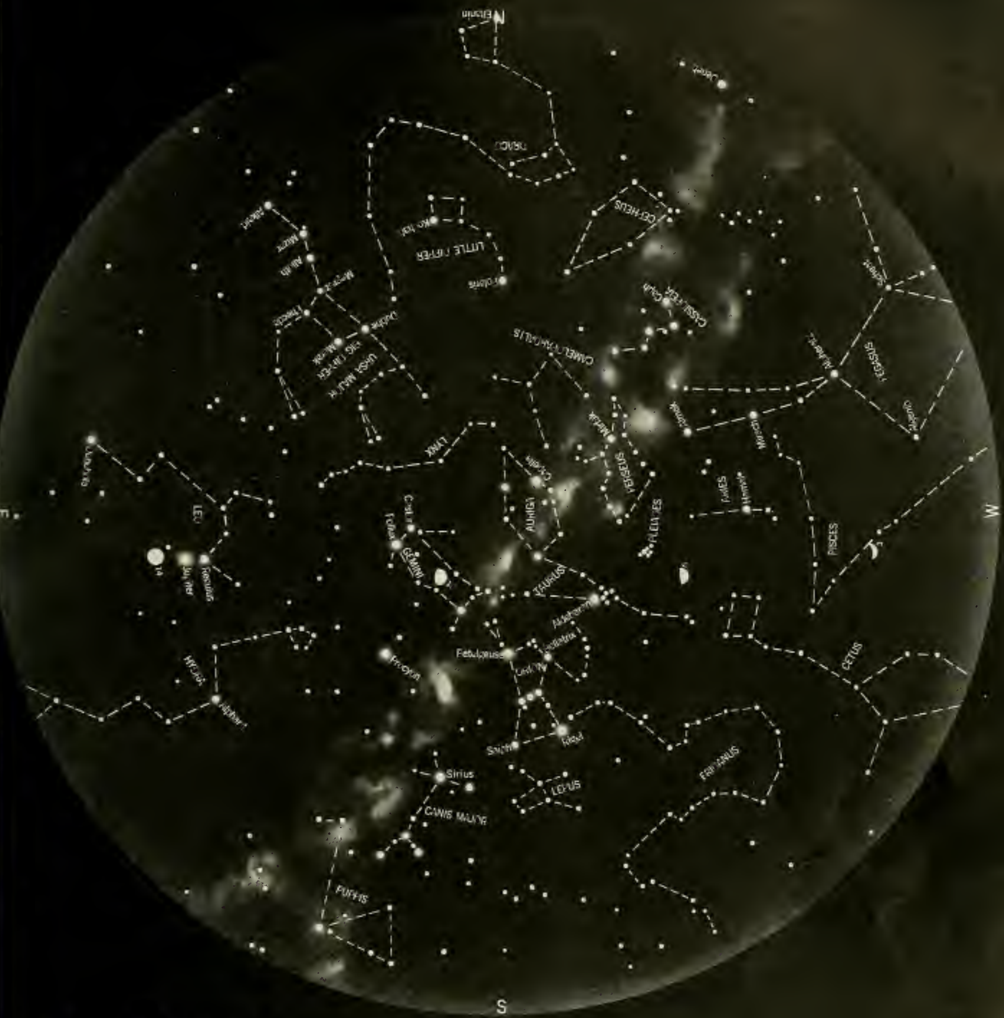
As Prendergast explained it, the hot gases from the exploding star would be pulled into a thin spinning disk by the primary star. Friction within the disk would result in some of the particles falling into the primary.

His calculations showed, Prendergast said, that a primary star of about the mass of the sun but ten times as dense seemed to satisfy the requirements. To produce the strength of X-ray activity observed on the rocket flights, such a primary would require an amount of hot gas equal to the mass of the sun every million years.

The second X-ray source to be identified with a visible star, an object in the constellation Cygnus, did turn out to be binary; but this star, which appeared hot and blue as predicted when it was discovered in 1966, was found to be yellower and cooler last summer.

The field is still excitingly new. The first X-ray sources were found only five years ago and first identified with a visible object just last summer.

John P. Wiley, Jr.



CELESTIAL EVENTS

In February the moon is in the evening sky until the 14th, in the morning sky thereafter. First quarter is on the 6th, full moon on the 14th, last quarter on the 20th, and new moon on the 28th.

Saturn and Mars are evening stars all month; Mercury for the first few days. All three are low in the west to southwest at dusk, setting soon after. Jupiter is prominent all night long, rising in the east at dusk, highest in the south about midnight, setting soon after dawn. Venus is a morning star, rising just before dawn.

February 1: The early crescent moon may still help you to find Mars, just to the right and below the moon, in the southwest at dusk.

February 2: The bright object just to the left of the crescent moon is Saturn, among the stars of Pisces.

February 5: Mercury becomes stationary in right ascension and begins to move retrograde (west). It resumes direct motion (eastward) on the 27th.

February 13-14: The bright object to the left of the moon on the 13th is Jupiter. Watch the distance between the two diminish during the night. On the night of the 14th, Jupiter is to the right of the moon, and the distance increases during the night.

February 15: Mercury is at inferior conjunction, passing between the earth and sun, and enters the morning sky.

February 20: Jupiter is at opposition, brightest for the year (magnitude −2.1) and nearest the earth (408,090,000 miles distant).

February 25: Venus rises shortly after the late crescent moon this morning and follows the moon up the sky, as it fades into the dawn.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on February 1; 10:20 P.M. on the 15th; 7:30 P.M. on the 29th; but it may be used for about an hour before and after those times.

Chipping Stones in the Outback

Within a few years the Australian aborigine way of life will disappear. They are the last of the hunter-gatherers who still practice stone-flaking techniques

by Richard A. Gould

Click! Click! The thin sound of stones being struck together reached me through the hot summer air as I walked along the bottom of the dry creek bed toward camp in the Clutterbuck Hills of the desert area of Western Australia. Rounding the last bend I found an aboriginal man, sitting cross-legged, striking flakes from a water-worn pebble. I realized as I watched him that I was witnessing a scene that has taken place repeatedly throughout the whole of human history, from the time of earliest man to the present. Stone chippings like these, mundane artifacts to be sure, have been one of the most important sources of evidence for archeologists studying the cultures of ancient man. Indeed in some places they are the only evidence. Because of their importance, archeologists constantly have sought ways to interpret how these ancient tools were made, their functions, and their role in prehistoric cultures. Furthermore, the archeologist has often used these same tools to distinguish one group of prehistoric people from another.

Most archeologists begin their interpretations along strictly archeological lines. By this I mean they examine the artifact itself in an attempt to determine its method of manufacture and its use.

A stone arrowhead, for example, is usually easy to identify by inspection. Other kinds of stone tools may be harder to interpret, requiring close and at times microscopic analysis of such things as breakage and wear patterns, weight, size, raw material, and different kinds of chipping.

Archeologists also check their excavation notes to see if the artifact might be associated with something else that will provide clues. If, for instance, a certain style of projectile point is characteristically found associated with the remains of a certain species of game, the archeologist may infer not only the basic function of the artifact but also its role in a special pattern of hunting.

Inevitably, archeologists must turn to historical or ethnographic sources for ideas on which to base any but the most superficial of interpretations. How much harder it is to understand the ancient arrowheads you have uncovered if you do not know about the bow and arrow!

The reports left by early explorers and chroniclers as well as by trained ethnographers do not always supply the needed background information. These explorers and chroniclers may have been more interested in finding gold, looking for good pasture and farming land, or other practical matters than in collecting facts about the industries of the aboriginals they encountered. Ethnologists, while they are interested in the native peoples of an area, tend to be more concerned about ceremonies, kinship systems, language, and other matters than with the parts of the culture that are likely to leave behind tangible remains—such as stone tools, pottery, and other material "hardware"—for archeologists to excavate and study.

Today there is a growing interest in the lives and behavior of ancient people who lived by hunting and gathering wild foods. Most of human prehistory is the story of hunter-gatherers, and it is therefore no surprise to find that many archeologists have directed their efforts entirely toward recovering the cultures of ancient hunter-gatherers. But these archeologists, like myself, have discovered gaps in our knowledge of living, present-day hunter-gatherers. The Congo Pygmies, the Bushmen of the Kalahari Desert, and the aborigines of the Australian desert are about the only people left in the world today who still live entirely this way, and in all three cases rapid changes in their cultures are coming about through contact with Europeans. The time is fast drawing to a close when people like these can still be found living in their normal habitat, depending on their traditional foraging economy.

Although archeologists spend much of their time classifying the stone tools they uncover, hardly anyone has ever attempted to learn how the native peoples themselves classify their stone tools. It has been argued that archeologists should try to make their systems of classification conform to those of the people who originally made and used the artifacts. Thus the archeological ordering of the materials would be more realistic, for it would reflect what went on in the mind of the native user rather than simply what went on in the mind of the archeologist, and would thereby increase the prospect for meaningful interpretation. This is a good argument, but it presupposes that there is a body of evidence on how native people do, in fact, classify their artifacts. Such evidence is generally lacking, especially for hunter-gatherers.

Of the three societies available for study, only the aborigines of the Gibson Desert of Western Australia were known to make and use stone tools as a regular part of their behavior. My wife and I went there in 1966 and lived with aboriginal families both in the desert and on Aboriginal Reserves for about fifteen months.

Owing to their isolation in this arid country, direct contact with Europeans came only in the last two or three years for some of these aborig-

An aborigine sharpens the edge of a stone adze by biting off small flakes with his teeth.

Great care is taken in selecting the proper stones from which the aborigines fashion their tools.

ines, with at least one family being contacted by government patrols as late as July, 1967. These are mainly Ngatatjara and Pintupi people, all of whom speak various dialects of Pitjantjatjara, a language in use over wide areas of the western desert of Australia. In the desert, these people live entirely by hunting and collecting wild foods, moving on foot over long distances from one water source to another. The nomadic nature of their existence puts a premium on portability in their material culture.

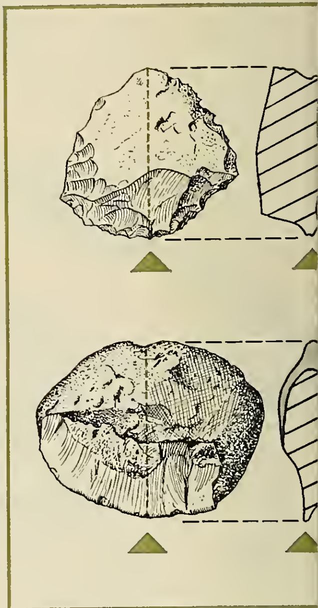
The desert aborigines classify their flaked stone tools into two categories, basing this distinction on the cross-sectional shape of the working edge (*yiri*) of the stone flake from which the tool is fashioned. A fairly thick flake with a steep working edge suitable for adzing or scraping in making wooden objects is called *purpunpa*. A knifelike flake with a thin, sharp edge suited for slicing or cutting is termed *tjimari*. In nearly every case, adze flakes (the term "adze" used here is not to be confused with the much larger adze more commonly thought of as used by shipwrights or by native woodworkers in some parts of New Guinea) are retouched along an edge to provide a sharp scraping surface. They are almost always hafted to the base of a wooden club or spear-thrower. In appearance, they resemble prehistoric stone tools (called scrapers by archeologists) from other parts of the world. Perhaps some of these were also hafted for use as woodworking tools.

Knives are retouched only if the cutting edge needs it, and this retouching is always done on one side of the edge only. In most cases, however, the extremely sharp edge of the freshly struck flake is regarded as sufficient. Flakes used as knives are sometimes given a "handle" by attaching a lump of gum, made either from spinifex (*Triodia* sp.) or blackboy (*Xanthorrhoea thorntonii*) resin, to the blunt edge of the flake.

Sometimes, if the worker is in a hurry, a sharp flake is selected, used for the immediate task, and discarded afterward. This often occurs during the butchering of kangaroos and emus, when the man doing the butchering grasps the flake between his thumb and forefinger while slitting the animal's belly, cutting leg tendons, and removing the feet and tail.

Adze flakes are the most distinctive and widespread class of stone artifacts made by the desert aborigines. Among the Pintupi and Ngatatjara people these tools are made in three different ways. First, there is the technique of direct percussion by means of a small hammerstone. The flake is held horizontally, bulbar face upward, in one hand (before being hafted) while sharp blows are directed downward along the edge with a small stone, usually a smooth, rounded pebble. While doing this the worker generally steadies himself by propping the elbow of the arm holding the adze flake against his knee while seated in a cross-legged position. In a matter of from ten to twenty seconds, a row of tiny flakes is removed from the underside of the edge, and the flake is then ready to be hafted to a club or spear-thrower.

Often, however, the flake is first hafted and then trimmed by means of gentle blows struck with a wooden stick. In this case the hafted flake is cradled, bulbar face upward, in the



The two basic categories of flaked stone tools are the broad-edged adzing tool (purpunpa), top, and the narrow-edged knife (tjimari), bottom, shown both in full view and cross section. The knife is set in a gum "handle." Arrows indicate the cutting edges.

An adze flake is hafted to the base of a spear-thrower with the resin of native plants, usually spinifex.

hollow of one hand with the working edge cushioned against the fleshy part of the thumb. The other hand taps a stick along the edge of the flake, detaching a row of small flakes in about twenty seconds.

Finally, there is the most remarkable technique of all—that of biting the flake in order to trim the edge. This practice, which apparently does not damage the teeth, has been observed before among the desert aborigines by Professor Donald Thomson, but it has not been studied in detail. The only other mention of this technique I know of comes from Coronado's chronicler, Casteñada, who observed this method of stone flaking on the Great Plains of North America in 1541. To accomplish this technique successfully the worker must have "flat teeth," that is, teeth with the crowns worn down to a flat, rather than a serrated, surface. This is a common physiological feature among people who normally eat foods containing large amounts of grit.

Another prerequisite for this technique is exceptionally strong jaw muscles. In this respect, too, the desert aborigines are well endowed, for their diet contains many tough foods, particularly meat that would be regarded as grossly undercooked by European standards.

As a woodworking tool the hafted stone adze is surprisingly efficient. It takes a desert aborigine only about twice as long to complete a woodworking task with a stone adze as with metal chisels and axes. Using metal tools he can produce an undecorated wooden spear-thrower in about four to five hours of continuous work; with a hafted stone adze the same task can take about eight and a half to nine hours.

Perhaps the supreme test of the stone adze comes in making a transverse cut across the grain of a mulga

To resharpen an adze, gentle taps of a stick remove a row of small flakes in about 20 seconds.

(*Acacia aneura*) stave to form the tip of a digging stick. It is fairly easy to shave away the wood surface if one is working with the grain of the wood, but working across the grain of this hard wood is difficult and requires a special technique. The tip of the digging stick is placed in a small fire and allowed to char. The char is scraped away with the stone adze until the surface is clean, then it is charred and scraped again, and the process is repeated until the point on the tip of the digging stick is completed.

Some archeologists have speculated on the possible advantages of "fire hardening" of spear tips and digging sticks recovered from ancient sites in Europe and elsewhere, but the behavior of the desert aborigines indicates that, far from hardening the wooden tip, this technique of charring serves to soften the outer surface of the wood and makes it easier to scrape away with a stone adze or abrading stone.

During use there is a tendency for the center of an adze flake to wear faster than the outer edges, resulting in a slightly concave edge. Retouching is aimed at straightening and sharpening and may occur as many as twenty times during the course of making one undecorated spear-thrower. Usually the flake is reversed in the haft during the job, and the flake is finally worn down to an absolutely characteristic slug. Under magnification these worn slugs have minute "ridges" running across the steep face of the flake. They are among the most common artifacts in aboriginal campsites.

There is one type of adzing tool used by these aborigines that has never been reported before from the Australian desert. This is a small engraving tool that is included within the range of artifacts called *purpunpa*, but which is also given a special term, *pitjuru-pitjuru*. It consists of a small flake with a fairly thick but narrow tip. In about half the cases I observed, this flake was given some secondary trimming after being hafted, but otherwise it was not retouched until it grew dull from use. It is set into a gum haft at the end of a short handle, 10 to 16 inches long. Unlike ordinary adzes, this tool is regarded as a sacred object and is never shown to women, children, or uncircumcised men. It is the most specialized stone tool made by the desert aborigines and is used exclusively for making the incised decorations on sacred boards and decorated spear-throwers.

All flake knives are called *tjimari*, regardless of their size (which ranges from $\frac{3}{4}$ to 4 inches in length and $\frac{1}{2}$ to $2\frac{1}{2}$ inches in width) or the degree to which they are treated as sacred. The larger flake knives (generally without a handle) may serve more mundane functions, such as cutting up small game, sinews, and a variety of other domestic purposes. Unlike smaller knives that are used mainly for circumcising male novices, these large knives have no sacred connotations and can appear openly in camp with no restrictions on who can see or use them.

In most cases these knives are discarded after only a few uses, and no effort is made to resharpen them. Thus they rarely show much in the way of secondary trimming and could be extremely difficult for an archeologist to recognize once the gum handle has decomposed. At times the hafted adze may be used as a cutting tool in butchering game, but this is unusual and happens only when no flake knives are readily available.

A *yalkara*, or hand ax, generally consists of nothing more than a hand-held rock with a sharp edge, picked up off the ground when needed and thrown away after use. On every occasion when I have been present, these have been used only for woodworking tasks, such as cutting spear shafts or detaching wooden slabs for shaping into spear-throwers or sacred boards. This latter task is accomplished with wooden wedges and either a large rock or a piece of wood used as a hammer. My informants say that sometimes they trimmed the working edge of the hand ax with rough percussion flaking, but this has been less frequent since steel axes have become available.

One of the usual explanations for

Smoothing a spear shaft, left, this
nan uses an adze attached to a spear-
thrower. The close-up, above, shows
the adzing process applied.

ontact with advanced technology has caused rapid changes in aborigines' ice of tool materials. A piece of glass, ove, is used to sharpen a spear, while he leaf of a Land Rover spring, right, as replaced the stone adze used in the pictures at top. New or old, the tools are used in identical fashion.

the use of Paleolithic hand axes in Africa and Europe has been the suggestion by many archeologists that they were used in butchering large game. In most cases, there is no reason to doubt this interpretation, but it is interesting to point out that the desert aborigines butcher all their large game (kangaroos, euros, emus) by means of wooden wedges, using untrimmed rocks or logs for pounding and small stone flakes or flake knives for cutting the skin and tendons. Among these people stone hand axes are used almost entirely for woodworking. Perhaps wooden-wedge butchering was a more widespread or even typical technique in the past.

Although the aborigines do not attempt to enhance the appearance of stone tools by careful trimming, they do tend to place an esthetic value on cherty materials of different color and texture. All agree that rough, grainy white quartzite is poor material, and they will use it only when absolutely nothing else is available. Natives from the Warburton Range area prefer the white chert found in quarries near there. The Pintupi and northern Ngatatjara men prefer the yellowish quartzites and creamy yellow cherts found in their region. These preferences have little to do with the actual working qualities of the different materials, for all are satisfactory materials for stone chipping. Rather, they reflect the close totemic ties each man has to the particular region from which he comes. The localities of these quarries often figure as places where "dreamtime" heroes, or *wati tjukurpa*, performed creative acts, and are venerated by men who believe themselves to be patrilineally descended from these ancestral beings. Thus a man may have a sense of kinship with some of these chert quarries, and he will value the stone material from them as a part of his own being.

In March, 1967, I met an extended family of twelve Pintupi people near Tjalpu-tjalpu waterhole. One of the men in the party carried a small bag containing yellow quartzite flakes from Partjar, some fifty miles to the northwest. Another man in the party had left a pile of sixteen small, round pebbles in front of his shelter at Tika-tika, the previous campsite. He had transported these from Part-

jar and intended to use them as hammerstones.

Here again, the aborigines have provided the archeologist with an interesting explanation for a problem he has most often explained by trade. Perhaps much of the occurrence of materials from distant areas was a matter of personal preference on the part of the individual who collected the material.

Formal instruction in the art of stone chipping and related techniques is at a minimum. Little conversation occurs at these times, but the children watch closely and sometimes try later on to imitate their parents' actions, using scraps of stone or wood lying about the campsite.

Since the making of stone tools does not apparently depend on conversation, those archeologists who have from time to time inferred the beginnings of speech from the complexity of the artifacts found at early sites might well profit from this observation. It might be added, however, that conversation does play an important part in the selection of raw material for tools. At such times the conversation is highly animated, as the virtues of this and that chert are hotly debated.

When contrasted with sacred activities, the chipping of stone tools is regarded by these aborigines as an art of little importance, the way Americans might, for instance, treat the matter of tying one's shoelaces. This casual attitude can raise certain problems for the archeologist. For one thing, there is a tendency for these people to pick up ancient stone tools from the surface of sites where they are camped and reuse these implements. Small, finely made, crescent-shaped tools of chert, along with other small, rather elegantly made stone tools (loosely classed as "microliths"), occur on the surface of many old campsites, and recent stratigraphic work near Warburton has shown that these tools predate the present culture of this region.

On one occasion I saw a Pintupi man at Partjar pick up an unusually thick lunate and haft it to his spearthrower. He called this *yiraputja*, and I learned that any obviously worked but unidentified stone item like this, as well as any substance foreign to the area such a pearl shell, is classed by this term. It includes any substance these people think was left behind by the totemic beings in their dreamtime travels. This category is distinctly different from *kanti*, a word used to define any unworked, chertlike material suitable for making stone tools.

Reutilization of already ancient materials may have been fairly common behavior among prehistoric peoples in many parts of the world. It can result in the discovery of early tools in much later levels in an ancient site and is another possibility the archeologist must consider if he is to interpret his finds correctly.

Once my wife went out to collect honey ants with some Ngatatjara women from the Laverton Reserve. While they were out, one of the women's dogs chased and killed a kangaroo. One woman picked up a natural flake of rough quartzite from the ground and used it to slit the animal's belly and cut the intestines. Then the stone was thrown away (and later collected by my wife). On another occasion, I was traveling near Mount Buttfield, about two hundred miles northeast of Warburton, in the company of two Ngatatjara men from that region. These men had caught several goannas early in the day. In camp late that afternoon they roasted these lizards and ate the fleshy parts. Then they placed the backbone, head, shoulders, and tail on top of a small rock, which they used as a kind of anvil. With handheld stones, they pounded the cartilaginous bone and scraps of meat together into a pulpy mass, which they then ate.

At times I have seen men pick up an untrimmed flake of chert and use it as a kind of spokeshave by gripping it between thumb and forefinger and scraping wood from the shaft or point of a spear. This usually happens when a man, for one reason or another, does not have a hafted adze with him. Generally the flake is tossed away when the task is finished.

In all of these cases, completely untrimmed rocks were used as tools. Also, with the possible exception of the spokeshave, they were not used long enough to cause any appreciable wear. Unless such items were found in clear association with other cultural materials, it might be impossible for an archeologist to recognize them as tools. In their simplicity these instant tools are on a par with the controversial eoliths debated by archeologists for many years, and they are a persistent feature of the stone technology of the desert aborigines.

At every turn, the desert aborigines present us with the unexpected. Archeologists do not ordinarily classify stone tools on the basis of the working edge (shape and size are usually thought to be more important), but the aborigines do. Archeologists do not ordinarily consider wooden wedges as possible butchering tools, but the aborigines do. Although there is nothing else in the world today quite like the aborigines' hafted stone adze, this kind of woodworking tool may have been more widespread in the ancient past. It has become an established archeological convention to speak of fire hardening of ancient wooden spear tips and digging sticks, yet the aborigines fire soften theirs! Evidence of transport of lithic materials is common in ancient sites throughout the world. Trade is often invoked to account for it, along with simple carrying of the stone from one place to another. But why do people do this? The aborigines' unique reason is that they are motivated by sentiments of kinship toward particular totemic beings close to the source of the stone. The desert aborigines chip stone with their teeth. Perhaps this technique, too, was more widespread in ancient times, as suggested by Castañada's account.

In short, the desert aborigines present archeologists with a set of new possibilities to use in interpreting the lithic remains of prehistoric hunting-and-gathering people. The opening up of these new possibilities is the chief value of continued ethnographic studies by archeologists. In four or five years the opportunity for studies of this kind will probably vanish as the aborigines adjust to life on reserves and in nearby towns.

At a winter camp, a Ngatatjara family sit by their campfire built between brush windbreaks.

Three community members are pipefish (at top), green boxfish (right), seahorse (far right). Next to photo of a turtle grass bed (above) is one showing Thalassia *plant in bloom.*

The Turtle Grass Community

A casual observer sees only quiet beds of underwater greenery. Actually they swarm with marine life. Such creatures as the seahorse, sea cucumber, and pearlfish depend for shelter and food on meadows of Thalassia testudinum, *the land plant that went to sea*

by William M. Stephens

Ecological ties are varied on
the grass flats. The shrimp at left
uses an anemone as host; above, a
sea urchin shields a shrimp.
At top of page, left, decorator cra
on blade of turtle grass has
camouflaged even its legs with
filaments of algae. Crab to the rig
holding to a gorgonian, is adorned
with bits of calcareous plates
from another algae species.

Along the lower Florida coast and throughout much of the Gulf of Mexico, the Bahamas, and the West Indies, the turtle grass beds spread over the shallow bottom like a mottled green carpet.

Myriad organisms live in these beds, feeding on one another and on the grass itself, which serves as substrate, cover, and camouflage, and a source of oxygen and nutrients. The beds are a veritable nursery ground for marine life.

Turtle grass (*Thalassia testudinum*) is a flowering, seed-bearing plant, one of the few to be found in the sea. It is a sea grass, not a seaweed. Seaweeds are algae–primitive plants that have no roots. Their root-like holdfasts are for attachment only and do not carry food to the plant. Also, algae do not bear seeds; they reproduce by spores or by division. Sea grasses, on the other hand, are relatively "modern" plants that originated on land about 60 million years ago. In their development it was only recently, by geologic standards, that they invaded the sea. There they grow on sandy or mud bottoms from the shoreline down to considerable depths. The maximum depth depends upon the clarity of the water, as sea grasses must have sunlight. Their flowers bloom under water, and the pollen is borne by the currents. Fruits develop, and the seeds eventually "fall," to germinate in the substrate in much the way that the higher plants propagate on land.

Although turtle grass is the most abundant and important sea grass found in tropical Atlantic waters, two other species are frequently found in close association with it. These are the manatee grass, *Syringodium filiforme*, and the shoalgrass, *Diplanthera wrightii*. The three species can be easily distinguished by their leaves. Turtle grass has long flat leaves about one-half inch wide and from one to two feet long, manatee grass has thin cylindrical leaves, and shoalgrass has flat leaves about one-sixteenth inch wide. In terms of habitat, shoalgrass is generally found growing next to the shore, where it may even be totally exposed at low tide. Turtle grass and manatee grass, on the other hand, grow from just below the limits of low tide to depths of more than 30 feet; and these sea grasses are often found intermingled.

To a casual observer drifting in a small boat over a shallow turtle grass flat, the area seems sparsely settled. Except for a few fishes and an occasional sea cucumber, starfish, conch, or sea urchin, few animals are immediately apparent. Yet the area is literally teeming with life, both on and among the flat blades of grass and in the soft bottom.

In a recent study of turtle grass by Dr. Donald R. Moore of Miami's Institute of Marine Sciences, quantitative sampling was done at several locations in Biscayne Bay. Two sampling methods were used: a push net and a "plug" sampler. A push net is effective in collecting the free-swimming and other unattached animals that live among the blades of sea grass; along with fauna the plug device removes a section of bottom down to a depth of 12 to 16 inches.

At one location a few miles south of Miami, these sampling techniques produced an average of 72 small shrimps in each square meter of turtle grass flats. In addition, each square meter produced the fantastic total of 20,960 tiny snails of four different species and 8,170 clams of two species. Based on these samples, a square mile of turtle grass will contain about 235 million shrimps and 95 billion mollusks. Although most of the animals taken in this study would be too small to serve as food for man, they are a source of food for fishes and edible crustaceans such as blue crabs, stone crabs, and spiny lobsters.

Many of the snails and crustaceans found in turtle grass beds feed by scraping bacteria, protozoans, or algae from the blades of grass. (As many as 113 different species of algae live as epiphytes on the blades of *Thalassia*.) Other animals eat the grass itself or feed on organic material in the soft bottom. Bivalves, sponges, and tunicates extract food from the plankton-rich waters, which they pump through their bodies.

The importance of sea grasses is shown by the virtual disappearance some years ago of the eelgrass that once flourished along the Atlantic coast from southern North Carolina to Labrador. (The eelgrass, *Zostera*, should not be confused with *Diplanthera*, which in northeast Florida and Georgia is also called eelgrass.) Worldwide in distribution, eelgrass is the dominant sea grass in temperate and subarctic regions, particularly in protected bays and estuaries, where healthy beds are sometimes so dense that an outboard cannot navigate through them. Such a tangled jungle is an ideal habitat for numerous species of fish and invertebrates, and furnishes food for many waterfowl.

In 1931 a blight, later traced to a fungus, struck the Atlantic eelgrass beds. Almost overnight, millions of acres of productive coastal waters were virtually stripped of all life. The mud and sand of many bays, no longer held in place by the roots of the eelgrass, washed away, destroying the habitat of burrowing forms. Some invertebrate species disappeared entirely and others, after being thought extinct, required many years to make a comeback.

By 1933 eelgrass was almost nonexistent along the Atlantic coast, except for a few surviving beds in areas of very low salinity—such as the mouths of rivers—where, presumably, the disease-causing organism could not survive. By the 1940's, however, eelgrass was definitely on the increase again. Today some beds are as luxuriant as ever. In a few more years the eelgrass beds may be as abundant as they were 35 years ago. In contrast, the turtle grass beds have not been threatened by disease.

Besides furnishing food and greatly increasing the surface area to which algae and animals can attach themselves, the sea grass beds afford cover for countless crawling and swimming organisms. Slender pipefishes live in prodigious numbers on the grass flats, often hanging vertically and strongly resembling blades of grass. Almost as difficult to see are the seahorses. Clinging to the blades with their prehensile tails, the 1½-inch dwarf seahorse (*Hippocampus zosterae*) is abundant in most grass beds. Its 6-inch relative, the giant, or spotted, seahorse (*H. erectus*), is less common and is usually in the deeper grass beds, at depths below 6 feet. Seahorses display no fear of man, and skin divers can easily catch them by hand. Like pipefishes, seahorses

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feed on tiny shrimps, larval fishes, and other small organisms.

To many people, seahorses are no more real than sea serpents or mermaids. For these little fishes are utterly improbable. With their exterior of hard, bony plates and their habit of twisting and writhing, they seem more like reptiles than fishes. (Their close relatives, the pipefishes, often resemble small snakes as they wriggle through the grass beds.) The way that seahorses roll their eyes—each eye can rotate independently of the other—is also quite "unfishlike."

Like all of the tube-mouthed fishes (order Solenichthys), seahorses and pipefishes have a long snout, which is used like a drinking straw. By sucking water rapidly through the snout, they pull in their prey. Others in the group are trumpetfishes, cornetfishes, snipefishes, and shrimpfishes.

Seahorses swim quite slowly and are very adept at maneuvering in close quarters—perhaps a necessity for survival in the sea grass environment. Because their mouths are tiny and they feed only on moving prey, seahorses must be able to maneuver, back up, and "turn on a dime" with consummate skill. Their pectoral fins, located behind the head, are like little propellers (fluttering as fast as 70 times a second), and the dorsal fin, which serves as a rudder, beats in synchronization.

The seahorse-pipefish family is perhaps best-known for its unusual manner of procreation. The males give birth to the young. At spawning time the male and female come together. The female inserts a tube into an opening on the male's underside and squirts eggs into the male's brood pouch. There the eggs are fertilized by the male's sperm. The eggs then incubate within the male's pouch, which becomes greatly distended.

The young are born alive, and the male appears to suffer "birth pains" as he twists and squirms to force the wriggling youngsters out of the pouch. Giant seahorses that I have kept in aquariums have given birth to as many as 294 half-inch young in a period of less than 20 minutes. After ejecting such a brood from its body, the male quite understandably appears exhausted, as well as deflated. (According to some reports, papa seahorse will eat his babies if they swim in front of his snout. Many seahorses have given birth in my aquariums, however, and I have never seen a father eat its young.)

The dwarf seahorse produces only a few dozen young at a time. But this amazing fish—smallest and perhaps hardiest of all seahorses—can produce two broods a month. The eggs incubate for only about ten days, and the male is ready to mate again only two days after delivering a brood. In the warmer parts of its range, the dwarf seahorse breeds all year around. Spawning is halted during cold spells, but the species can live in water that drops below 50°F. Feeding is almost constant during daylight hours. Experiments have shown that a young specimen may eat as many as 3,600 newly hatched brine shrimp a day.

The giant and the dwarf are the most common inshore seahorses throughout the Gulf of Mexico and along the Atlantic coast from the Carolinas south. There are four other species present on the Atlantic coast, two on the Pacific coast, and a total of about 24 species around the world. Pipefishes are more abundant—about 150 species are known.

Many invertebrates of the turtle grass flats are even more adept at the art of camouflage than are the seahorses and pipefishes. The spider, or "decorator," crab cultivates a garden of algae on its shell, and the sponge crab holds a living sponge above its body with its two rearmost legs. One tiny spider crab camouflages its entire body, including legs, with thin filaments of algae; then it hangs from a blade of turtle grass, looking for all the world like a few strands of plant material wafting in the current. Some of the sea urchins (notably *Lytechinus* and *Tripneustes*) cover themselves with bits of shells, grass, coral, and other debris, using their efficient tube-feet to transfer the material to the top of their test, or shell. Studies have shown that urchins drop the masking material at night and recover themselves in the daylight.

Pound for pound, the sea cucumbers, or holothurians, are among the most abundant animals that live in the *Thalassia* beds. These sausage-shaped creatures are echinoderms, but their relationship to starfishes and sea urchins is not readily apparent to the casual observer. Holothurians are the only members of their phylum to have a "head" and "tail" end. All other echinoderms are radially symmetrical. The radial symmetry of the sea cucumbers is seen only in the ring of feathery tentacles that surrounds the mouth. When extended, they somewhat resemble the outstretched tentacles of a basket star or a crinoid.

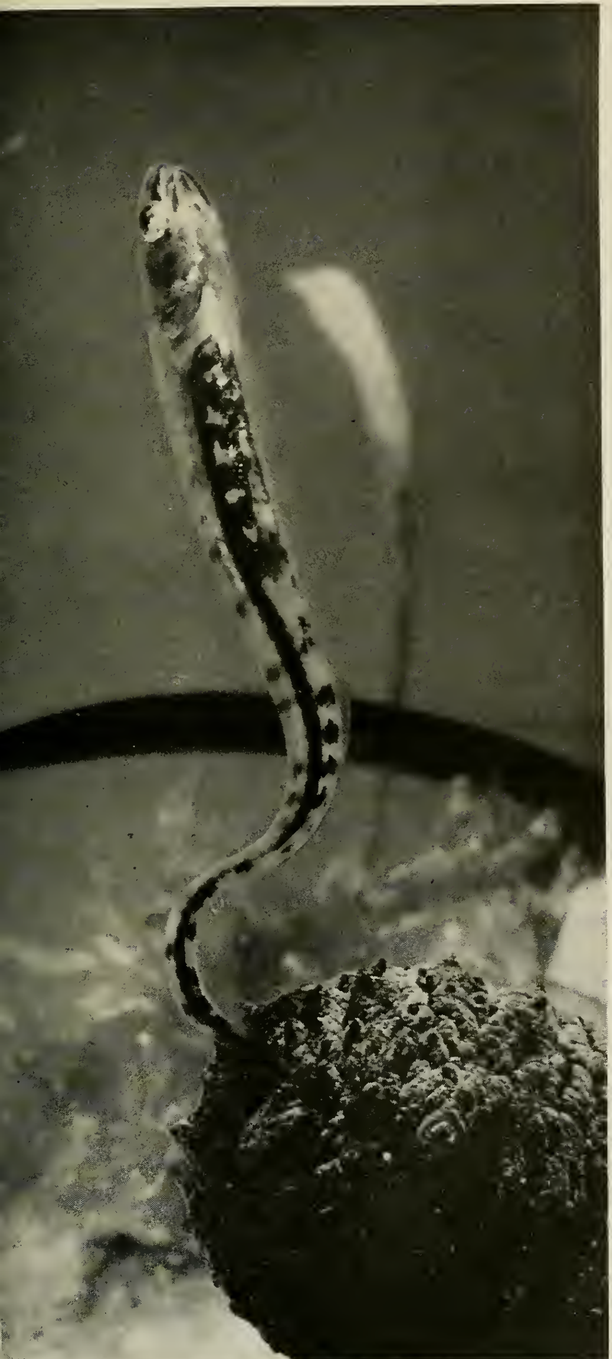
As a holothurian moves across the grass flats, its tentacles operate like a slow-moving vacuum cleaner, gathering sediment from blades of grass and picking up sand and mud from the bottom. Organic material is digested; inorganic material is passed through the body. Sea cucumbers can redistribute an estimated 90 tons of bottom deposits each month in an area two miles square.

Sea cucumbers have few enemies, owing perhaps to their unique defenses. Many of them contain toxins that are lethal to other marine animals. Natives of the South Pacific have long used crushed sea cucumbers as a fish poison, throwing the material into tidal pools and then gathering up moribund fishes. A large West Indian species, *Actinopyga agassizi*, may contain one of the most potent poisons known. Some researchers hope that an effective shark repellent can be developed from this natural toxin.

Just how the poison is produced is not known, but it is released when a disturbed holothurian apparently protects itself by performing the feat of discharging its internal organs into the water. Strangely enough, this process of evisceration does not harm the sea cucumber. It simply crawls away and regenerates a new set of organs.

Some holothurians, instead of eviscerating when disturbed, merely discharge sticky threads of material. Presumably, these "Cuvierian tubules" entangle a potential attacker, keeping him occupied while the holothurian escapes.

The toxicity of sea cucumbers does not appear to affect their edibility, and they are widely utilized as food in the Indo-Pacific regions, where



they are known as trepang, or *bêche-de-mer*. The visceral mass is removed and the thick skins are dried and then serve as a base for soup. In some areas the intestines of certain species are also eaten. On the east coast of Australia—particularly in Queensland—the *bêche-de-mer* industry ranks with the oyster fishery in value.

Some species of holothurians are host to a parasitic fish, called a pearlfish, which lives inside the sea cucumber. This is one of the most remarkable relationships in nature, involving, as it does, a highly developed vertebrate animal that uses a primitive echinoderm for bed and board. Some species of pearlfish leave their host to feed; others stay inside indefinitely, browsing on sea cucumbers' gonads and other tissues.

Pearlfishes belong to the family Carapidae and are found throughout tropical and temperate seas. More than a dozen species are found in tropical Indo-Pacific regions, several species in the Mediterranean, and one in the western Atlantic. Some Pacific pearlfishes live in clams, starfishes, and pearl oysters. (The common name of the fish may have resulted from the fact that it has been found "embalmed" in a coating of nacre within a pearl oyster.) The West Indian pearlfish, *Carapus bermudensis,* lives only in sea cucumbers. Sometimes it leaves its host at night to feed on small shrimps, copepods, amphipods, or other crustaceans.

In many parts of the world pearlfishes seem to be rare, but they are common in parts of south Florida and the Bahamas. In the Miami region Dr. Lowell Thomas and I have collected hundreds of sea cucumbers and have found that on some turtle grass beds near Key Biscayne about half of the collection contained fish. We found the fish living in three different species of sea cucumbers.

Pearlfishes enter their hosts through the anus, which in holothurians is used in the process of respiration. As the animal expands its body, water is sucked into the anus

Parasitic pearlfish locates anus of a sea cucumber, then turns to enter its host backward.

and courses through the respiratory trees, branching networks that extend up both sides of the body. Through them oxygen is absorbed into the body. When the holothurian "exhales," a stream of water is forcefully emitted from the vent.

When making its entry the pearlfish responds to the stream of outgoing water and approaches the anal opening. Young specimens of pearlfish sometimes swim up the stream of water and rapidly disappear, head first, into the cucumber's body. In most cases, however, the pearlfish puts its snout to the vent, whips its tail about and jabs it into the hole, and then works itself backward into the sea cucumber. Often the holothurian seems to try to prevent the entry by closing its vent. Several minutes may be required for the pearlfish to force its way inside, sometimes employing a corkscrew motion.

Pearlfishes have been found in different parts of holothurians' bodies. The species *Carapus bermudensis* is usually found within the respiratory tree or in the coelomic cavity. Apparently it ascends a tree and then breaks through into the body cavity.

Another aspect of life in the turtle grass beds is the environment they provide for the young. They serve as nursery grounds for juvenile sea trouts, jacks, pompanos, barracudas, mullets, snappers, stone crabs, blue crabs, spiny lobsters, and many other animals. Without the abundance of food found in the grass beds and the safety afforded from large predators, few of these young creatures would survive. Many ecologists fear that the continuing destruction of sea grass flats by dredging, filling, and pollution will do irreparable damage to countless game fishes and food fishes, as well as to scallops, clams, and other invertebrates. Already some bays on Florida's gulf coast have become virtual biological deserts, for turtle grass must have reasonably clean, clear waters of the proper salinity in order to survive and spread. *Thalassia* cannot tolerate either extremely salty or extremely fresh water. It lives no deeper than about 6 feet in Tampa Bay and other murky water areas, while it is often found deeper than 35 feet in the clear waters of the Bahamas and the Virgin Islands.

Strangely, very few large animals feed directly on the meadow-like expanses of sea grass. While land grasses are eaten by horses, buffalo, antelope, cattle, deer, and many other herbivores, no comparable "herds" of marine animals visit the sea grass beds. The manatee, or sea cow, *Trichechus manatus*, is a sea grass browser, of course, as is the green turtle, *Chelonia mydas*. But even though each of these animals gave its name to a type of sea grass, they are now unimportant in the ecology of the sea grass communities. Both were rendered nearly extinct by man, largely because of their ease of capture and the fine, beeflike flavor of their meat.

A few species of fishes and innumerable small invertebrates feed on the leaves of *Thalassia*, however. In a Virgin Islands study, Dr. John E. Randall found that parrotfishes and surgeonfishes feed avidly on any turtle grass that grows close to a coral reef—but these herbivorous fishes will not venture far from the protective shelter of a reef. Experiments showed that parrotfishes and surgeonfishes are responsible for the 30-foot band of bare sand that often stretches along the edge of a coral reef, separating the reef from the sea grass beds. This area is picked clean by the fishes, and no sea grass beds are able to get a start. Randall found that other fishes, including the halfbeaks and rudderfishes, eat floating sea grasses; and that one small species of parrotfish, which spends its entire life in the grass beds, also eats the grass. Several sea urchins also feed on *Thalassia*. Even the queen conch, *Strombus gigas*, which feeds primarily on filamentous algae, sometimes eats the leaves of *Thalassia*.

Turtle grass grows rapidly, each blade increasing in length as much as an inch a week. Each plant grows horizontally, also, by sending a runner, or rhizome, beneath the substrate, in much the way the "running" bamboos spread. Along the rhizome, every two or three inches, erect branches, or shoots, grow upward. Four or five leaves may be growing from a single branch. At the base they are surrounded by a sheath. After a leaf grows some 12 to 18 inches (or, in extreme cases, to two feet in length), the blade tends to die or to break off. Organic material from leaf decay adds continuously to the substrate and attracts foraging fishes, worms, crabs, and snails. Nutrients released as the blades decay help support a large population of plankton.

Leaf breakage may occur because of the weight of encrusting organisms or because the encrusting materials cover the blades so thoroughly that they receive no sunlight. In many cases, leaves may be nibbled on by marine animals until the riddled blades are broken off by the moving waters. Healthy green leaves are also broken off by conchs, helmets, or large hermit crabs dragging their shells over the flats, or by schools of mullet grubbing among the roots and rhizomes. The broken green blades usually float, while the dead blades sink and often accumulate in potholes to depths of a foot or more.

Rough waters and winds may bring these broken *Thalassia* blades ashore by the tons. University of Miami investigators Lowell Thomas, Don Moore, and Robert C. Work found that an estimated 15,685,410 pounds of *Thalassia* leaves were piled up on the west shore of Biscayne Bay by Hurricane Donna in 1960. Yet, strangely enough, a survey of living grass beds throughout Biscayne Bay showed no appreciable depletion or damage. According to the scientists, "Damage to the *Thalassia* and associated fauna and flora due to fresh water run-off in near-shore areas could be more severe than physical storm damage."

In tropical parts of its range, turtle grass plants bloom each summer. Although the beds are widespread in northern parts of the Gulf of Mexico, flowers or seeds are apparently not produced in any beds north of Tarpon Springs, Florida. Beds off north Florida and the gulf coasts of Alabama and Mississippi are perhaps seeded from time to time from areas farther south. But even without this seeding they may continue to spread over large, suitable areas owing to

Brood pouch shows this seahors is a pregnant male. It receiv and incubates the female's egg

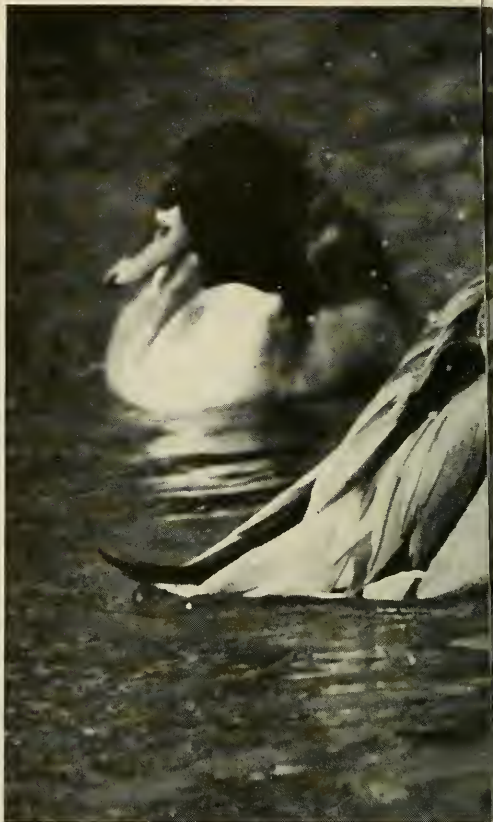
the rapid growth of their rhizomes.

Thalassia beds in the Miami region usually begin to flower in April (starting with the plants in shallow water) and may continue through September. Only a small percentage of plants in a given bed will be in bloom at any one time. The male and female flowers are found on different plants, and generally all plants in one bed will be male, while all plants in another bed will be female.

The fruit is about an inch in diameter. As it ripens it changes from bright green to a yellowish-green hue. An occasional fruit is red. Generally, wave action breaks the fruit away and it then floats on the surface. This assures a wide dispersal of the plants. Each fruit normally contains three seeds, which sink to the bottom when the fruit opens up. Within a few days root hairs develop and anchor the young plant to the sand or mud.

In this manner, turtle grass and related sea grasses spread and grow, extending their range while furnishing food and new habitats for the myriad organisms that make up the unique grass bed communities.

The Evolution of Duck Courtship



Grunt-whistles, down-ups, shakes, and sneaks are in the bump-and-grind display repertoire by which ducks identify drakes

by Paul A. Johnsgard

Because the word "courtship" is so imbued with human connotations, it may be debated whether the term should be applied to nonhuman reproductive behavior patterns. Nonetheless, analogous mating responses can be observed in many vertebrates, and it is instructive to ponder the reasons why such activities often bear a more than passing similarity to human courtship.

The similarities can be partially explained by considering reproductive efficiency. Since terrestrial vertebrates no longer reproduce in a watery medium that would permit simple external fertilization, it is vital that behavioral and structural adaptations be present that will allow for the direct transfer of sperm cells from male to female. Additionally, a prolonged association between reproductively active individuals provides maximum opportunities for synchronizing sexual cycles and preventing mismatings between species. Finally, most of these advanced vertebrates produce relatively few offspring, and it is therefore advantageous if a maximum amount of parental care is available to favor their survival. For such reasons, responses favoring the establishment of individual sexual associations, or "pair bonds," have evolved in some vertebrate groups.

In mammals, monogamous pair bonds are relatively rare and are well developed only among certain groups that give birth to highly dependent, or altricial, offspring. Monogamy among mammals is especially typical of those species, such as various carnivores, in which both the female and young must rely on the male for food gathering. However, the majority of birds produce altricial young and typically form monogamous pairs that normally persist through a single breeding season. Avian polygamy or promiscuity is primarily limited to those species producing precocial young that are easily able to forage for themselves shortly after hatching, to various species that nest near relatively unlimited food supplies so that the female alone can provide for the young, and to socially parasitic species that do not have to rear their own offspring.

It could therefore be expected that ducks, having precocial young, might tend to be polygamous, if not promiscuous. This appears to be the case for only a very few species, such as the Australian musk duck. However, the great majority of ducks annually form relatively clear-cut pair bonds which usually break up when the female begins her incubation. In only

Two of the conspicuous courtship displays mallards perform are the "grunt-whistle," left, and "head-up-tail-up," below. Displays such as these usually follow "preliminary shaking," in which the drake swims high on the water, then thrusts his head up and back, raising his body from the surface. Grunt-whistle derives its name from the sound made during the performance. Head-up-tail-up is self-explanatory.

a few duck species does the male remain with the female and help care for the young, and these are mostly tropical species with prolonged or irregular breeding seasons. The biologist is thus inclined to try to account for the possible value of such prenesting pair bonds in ducks, and to determine the functions of the elaborate courtship ceremonies performed during the period of pair formation.

The courtship of ducks is unusual in several aspects. In temperate zones it generally begins very early, usually on the wintering grounds, so courtship is not a manifestation of territorial proclamation and defense as is the case with many songbirds. Nor, because of its early initiation, is courtship closely correlated with gonad growth and fertilization; rather, pair formation is normally completed prior to the period of maximum gonadal activity. Therefore, reproductive behavior in ducks may be conveniently divided into an early phase of conspicuous displays associated with actual pair formation, followed by the later and less elaborate behavior patterns concerned with pair bond maintenance and fertilization. Two possible advantages of the considerable time lag between pair formation and egg laying are that it decreases the likelihood of uncorrected mismatings between species and, furthermore, provides the female with the protection of a mate to ward off unmated males that might attempt to rape her. An appreciation of the distinctly different functions of early versus later phases of sexual behavior in ducks will help to explain their widely differing behavioral characteristics.

The relatively stereotyped postures and calls, or "displays," associated with pair formation presumably originated as a result of various evolutionary factors. For example, the adult sex ratio of ducks is characterized by an excess of males, probably as a reflection of the greater dangers endured by the females during nesting. As a result, not all males are able to obtain mates, and a spirited competition among them naturally ensues. Therefore, those males having brighter plumages, stronger sexual responses, or increased social dominance will be at an advantage and will tend to be more successful in reproducing. Insofar as these differences have genetic origins a gradual evolution of more elaborate male plumages and displays may be ex-

pected. Thus, male ducks have generally more complex displays and brighter plumages than do females, which must remain inconspicuously colored if they are to nest successfully in the presence of predators. If such "sexual selection" were the only factor affecting male plumages and displays, one might well imagine that different species could be very similar in these respects, just as females are relatively similar in their plumages and vocalizations. But this is not the case, and it is a fact that no two species of ducks that are native to the same region have identical plumages or pair-forming displays. Likewise, all North American cricket species living in the same habitats have been found to exhibit diagnostic song repertoires (NATURAL HISTORY, November, 1966).

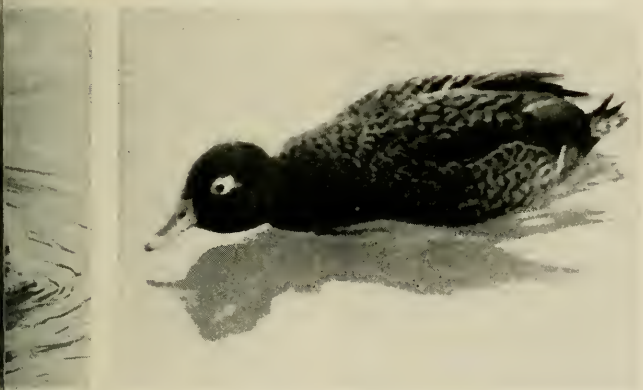
Such diversity would suggest that a major influence in the evolution of male courtship behavior is the need for achieving "species recognition," or a means of ensuring that females will be readily able to recognize and therefore mate only with males of their own species. It is generally true that males of many animal species are much less discriminating in their species-specific attraction to females than are females to males. The maintenance of such species' genetic integrity depends largely upon the females' ability to perceive the "proper" combination of male traits. It is presumably for this reason that such a variety of male plumages and elaborate courtship displays has evolved among birds. On the other hand, displays associated with pair maintenance and fertilization occur only after species recognition has been achieved. Such displays understandably show much less diversity within large groups of waterfowl.

We may therefore predict that distinctive pair-forming displays and male plumages will be present in groups of ducks having a considerable number of closely related species occupying roughly the same geographic area. In North America this criterion is fully met by the typical dabbling ducks (primarily *Anas* spp.). Thus, such abundant and wide-ranging ducks as the mallard, pintail, gadwall, green-winged teal, blue-winged teal, cinnamon teal, American widgeon, and shoveler all have unique display repertoires and brighter male nuptial plumages that readily distinguish the sexes. The remaining dabblers, in which males are inconspicuous and closely resemble females, include the black duck, mottled duck, Florida duck, and Mexican duck. All of these are mallard-like birds, which prior to historical times bred in areas where few, if any, mallards or other dabblers occurred. We might, in fact, regard them as mallards "in disguise," for not only are the males' displays and calls indistinguishable from those of mallards, but also the females' plumages and vocalizations are mallard-like. Indeed, recent changes in the mallard's distribution have resulted in hybridization between mallards and these populations in every region where they have come into contact.

The courtship displays typical of mallards may be used as examples of the male pair-forming displays of most dabbling ducks. Not one but several different postures and calls are present, all apparently having evolved from simpler, non-display responses including body-maintenance, or "comfort," activities, such as preening or shaking. Three courtship displays are especially frequent and conspicuous among mallards, and all involve variously stretching the neck and uttering a single or multiple whistle. These displays were first accurately described by the famous German ethologist Konrad Lorenz, who gave them descriptive names that have been translated as "grunt-whistle," "down-up," and "head-up-tail-up." It is fairly clear that the grunt-whistle represents a stereotyped, or "ritualized," modification of normal body shaking, and that the down-up is a similarly exaggerated form of drinking; but the head-up-tail-up is of less obvious origin.

This last display is actually only part of a complex sequence of postures, beginning when the male suddenly whistles while stretching his neck vertically, at the same time raising the tail and lifting his folded wings, thus exposing the purple wing-speculum pattern. This head-up-tail-up phase is usually performed at "profile view" to a specific female, and so provides maximum visual im-

The canvasback drake with i head lowered, top, perforn a display called the "sneak while the ruddy drake, center, le drums its breast to crea a "bubbling" display, which not on attracts females but al wards off male encroache The "nod-swimming" posture exhibit by the Laysan duck, center, rigl is performed by many mallard-li species and is one of t few courtship displays of femal At bottom, two ringneck mal flatten their head feathe to attract a female with a displ called "depressed cres



pact. The male then turns his head to point the bill toward the courted bird, and usually holds this rigid posture for a short time as he reorients his entire body toward the female. The male then typically lowers his head almost to the water and swims rapidly past her in a manner called "nod swimming," and finally terminates the sequence by raising his head and simultaneously directing his blackish nape feathers toward the female. Several other postures and calls also occur, but they appear to be of less significance in the mallard's pair-forming activities.

Although the grunt-whistle, down-up, and head-up-tail-up also occur singly or in combination in several of the other North American dabbling ducks, only the mallard-like ducks possess exactly this same repertoire of postures and calls. Thus, the male green-winged teal performs the same three displays much more rapidly with different relative display frequencies and vocalizations, and additionally has a "bridling" display, which involves drawing the head backward, that is lacking in mallard courtship. The male gadwall lacks both bridling and nod swimming, and, furthermore, its head-up-tail-up display is sequentially "linked" to the immediately ensuing down-up posture. The pintail, however, lacks the down-up display, and in this species there is a significant, although delayed, linkage between the grunt-whistle and the head-up-tail-up, which usually occur about one second apart. The pintail also seemingly lacks a functional nod-swimming display, although it is present in an extremely rudimentary form. The American widgeon, shoveler, cinnamon teal, and blue-winged teal all completely lack these particular displays, and instead have other species-diagnostic responses.

In a similar fashion, such interspecific diversity distinguishing the basic similarities of male plumages and displays can be seen in other North American waterfowl. All of the typical diving ducks (*Aythya* spp.) exhibit certain male displays such as "head-throws," "sneak" postures, and "kinked-neck" calls, but these displays differ greatly in their visual

and acoustical characteristics. Likewise, the three larger species of eiders (*Somateria* spp.) share certain movements and postures associated with cooing sounds, but each species has a diagnostic combination of displays that identifies it as decisively as its male plumage pattern. Several species of ducks having no near relatives in North America also exhibit relatively elaborate male plumages and displays, as does, for example, the ruddy duck. In such species it must be presumed that competition among males for mates has by itself been effective in the evolution and maintenance of these displays. Additionally, the male ruddy duck utilizes its remarkable breast drumming, or "bubbling," display both as a sexual response toward females and as a territorial advertisement display toward other males.

It has been generally believed that such pair-forming displays are entirely innate, as suggested by their stereotyped performance among all the individual males of a species. Furthermore, hand-reared male ducks that have never been exposed to experienced males will, when placed in the proper situation, perform their displays without a single mistake from the first time they are attempted. Likewise, downy young ducklings have been stimulated to perform species-typical courtship displays by hormone treatments. Finally, it has been recently reported that when mallards are reared with a foster mother of another species or with foster broodmates of a different species they do not exhibit that species' displays upon maturing. However, males reared under such conditions will usually become sexually imprinted on their foster species and may later mate with such females in preference to those of their own kind. Similarly reared female mallards, on the other hand, have a strong innate species-recognition mechanism that enables them to mate correctly in a later choice situation.

An additional proof of the hereditary basis for these species-typical displays lies in the intermediate responses performed by hybrid individuals. Hybrid fertility among ducks is unusually great, and it is often possible to hybridize species having widely differing male plumages and displays. For example, mallards and pintails have been repeatedly hybridized in captivity, and a few wild hybrids of this type are shot by hunters almost every year. Their frequency in the wild is small, but their very occurrence poses two important problems: Are they sufficiently fertile and reproductively active enough to compete with the parental types for mates and, if so, what sorts of display repertoires do they possess?

It is well known that first-generation hybrids between mallards and pintails have plumages and bodily proportions almost exactly intermediate between the parental types, as if the parents' genes were neatly blended in an equal mixture. Of greater interest is that their male display repertoires are also a composite combination of the mallard's and pintail's. Thus, such hybrids evidently lack the down-up display altogether, and their nod swimming is performed in a manner that is intermediate between the parental types. The hybrids are fully fertile, but under wild conditions the males would probably fail to obtain mates because of their intermediate plumages and displays, as well as having apparently reduced competitive responses. In captivity, however, the hybrids may be backcrossed with either parental species or with one another to produce second-generation hybrids. This procedure was first systematically carried out by the great waterfowl authority John C. Phillips, who found that second-generation males exhibit some individual variation indicating genetic segregation of mallard and pintail plumage traits, although less than he observed in crosses that involved only mallard-like species.

We repeated this experiment recently at the Round Lake Waterfowl Station in Minnesota, to obtain more specific information on the degree of plumage segregation in the second generation, and also to determine whether a similar segregation of behavioral traits related to pair formation could be detected. Twenty-three second-generation males were reared, of which about half were selected for behavioral study. These males varied greatly in their nuptial plumages, with some individuals so closely approaching the mallard type that they could scarcely be distinguished from pure mallards, while other males exhibited pintail-like plumages. Of greater interest was my student Roger Sharpe's finding that the mallard-like males performed their displays in a distinctly mallard-like manner. Some of these individuals were the only ones to perform the down-up display, for example. On the other hand, the pintail-like males were also pintail-like in their displays, especially with regard to the details of the head-up-tail-up sequence.

Our results support the view that these male displays are as much a reflection of the species' genetic constitution as are their plumage characteristics, and thus may be used to help characterize or define a species. The degree of individual variation observed in the second-generation males' plumages and displays was surprisingly great, suggesting that perhaps the genetic bases of these traits are relatively simpler than one might have otherwise supposed. Such simplicity of control would help to account for the occasional occurrence of individual mallards and pintails that perform their courtship displays in an atypical manner. Thus, males of both species have been observed performing bridling as a courtship display, although in these species bridling normally occurs only as a postcopulatory response. Interestingly, this same display anomaly has also been found in some of the hybrid males.

With simple genetic control of male display patterns thus indicated, their resultant susceptibility to changing pressures of natural selection makes the use of male display characteristics less valuable as a criterion of evolutionary relationships than Konrad Lorenz once enthusiastically proposed. However, other behavioral criteria such as female displays and various displays associated with pair maintenance and fertilization are much more uniform among related species and often provide valuable evidence concerning evolutionary relationships. Therefore, the fascination of pair-forming displays in male ducks now lies, not so much in their taxonomic applica-

ɜn though the neck-stretching display, called "reaching," of the king eider, above, is identical with that of the American eider, above, right, each bird performs it in a specific sequence of displays that identifies the eider as surely as its plumage. he "bridling" Cape teal, right, throws its head back and its chest up in a variation on the mallard theme. Each mallard-like species has its own diagnostic routine.

tions, as in understanding their obviously adaptive functions, such as maintaining reproductive isolation between closely related species. Thus, it is a pleasant mental exercise to try to predict what a particular unstudied species' male courtship displays might consist of, based on a prior knowledge of the displays of its nearest relatives, the presence in the same area of related species whose displays are already known, and the clues provided by the male plumage of the species itself, since displays evolve with and frequently expose species-specific plumage features. The usual result of such contemplations, upon learning the facts, is the chagrin of discovering that the results of natural selection often represent a seemingly more imaginative solution to the question than do the musings of flesh-and-blood biologists.

The Man and

THE NAKED APE, by Desmond Morris. *McGraw-Hill Book Co., $5.95; 252 pp.*

The heated controversies following the publication in 1859 of Darwin's and Wallace's papers on the origin of species by natural selection were rekindled in 1871 by the appearance of Darwin's *Descent of Man and Selection in Relation to Sex.* Subsequently, attempts to determine the nature of the human animal and his relationships to other animals (as well as the testing of the mechanisms of evolutionary processes) have resulted not only in vast numbers of scientific treatises but also in the development of new systems of study. One of the younger disciplines to be established is ethology, and particularly that segment dealing with the life and habits of primates in relation to their environment (and to each other), for example, sexual signals, grooming, social organization, mother–infant relationships, facial expressions.

A reasonable number of literate people now accept the fact of evolution, and an educated "guestimate" is that most of those liable to read *The Naked Ape* are already aware of man's primate heritage. The author, a zoologist interested in mammalian behavior, implies, by stating that he has "deliberately insulted us by referring to us as naked apes," that there is rife a feeling of shame about our common ancestry with non-human primates. He admits that this book purposefully presents a one-sided picture because "we find the contemplation of our humble origins somehow offensive." This is a highly debatable premise. However, he demonstrates, in an interesting "experiment" with 12,000 children that at the head of the "top ten in animal loves" are the chimpanzee and the monkey!

I consider the implications of the title "naked ape" entirely misleading and deceptive. "What's in a name?" is a special problem of zoologists who have specifically and generically separated man from the apes for very positive anatomical, physiological, and behavioral reasons. Similarly apes and monkeys. The relationship is no insult, but a triumph of evolution. To ignore it for whatever convenience or gimmick is to subscribe to the continuation of precisely the ignorance that the author professes he is attempting to enlighten. The common usage of "naked" means unclothed or nude, and hardly "hairlessness," which Morris considers a unique feature of man, a statement many would debate, especially the Ainu.

In his final paragraph the author assumes the role of a moralizing advocate. He admonishes the optimists who believe: "that since we have evolved a high level of intelligence and a strong inventive urge, we shall be able to twist any situation to our advantage; . . . that when the time comes, we shall manage to cope with the over-crowding, the stress . . . that we shall re-model our behaviour patterns . . . that we shall control our aggressive and territorial feelings, our sexual impulses and our parental tendencies; . . . that our intelligence can dominate all our basic biological urges." He states, "I submit that this is rubbish. Our raw

The Metropolitan Museum of Art

Ape Affair

animal nature will never permit it."

What an extraordinarily dogmatic conclusion, divorced from our biological reality, when the total impact of the evolution of culture has been precisely to widen the gap between man and other animals, and when our educational processes, technological advances, police forces and judiciaries, psychiatrists and psychologists, *inter alios,* have geared the pitch of corrective measures at the ugly heads rearing from our so-called animal instincts. These things, like evolution, are ongoing processes, shifting this way and that. We try to understand our "imperfections," but constant reference to our animal origins will not of necessity induce the changes of progress. Natural selection is happening around us all the time, and our remarkable variability and ingenuity will trace a genetic path of success, at least for some. If the evolutionary processes fail sapient man, it does not spell doom, as the author forecasts, but a swing in an unforeseen and undeterminable (at present) direction. I am one of the optimists who has great faith that our genes will see us through! The author offers the eugenic, rather contradictory (to his own pessimism) solution "that we should tailor our intelligent opportunist advances to our basic behavioural requirements. We must somehow improve in quality rather than in sheer quantity." Unfortunately, in a sense, the "quantity" is often taken care of by those animal urges that in recent centuries have led to religious persecution, genocide, and territorial aggression, and by the decimating role of the environment (disease, starvation, floods).

The American Museum of Natural History

Many speculative interpretations of the behavioral origins of our daily activities are presented in this book in an interesting and, occasionally, informative manner. But why invoke moral causes and issues in the present embryonic state of our knowledge of behavior patterns?

It has become a popular game to overdramatize the non-dramatic, namely, that man is an animal who shares many behavioral patterns with his related forms (see also R. Ardrey's *African Genesis*). There seems to be a peculiar pleasure in exposing man as a stripped animal, and descriptions contain loaded (unpleasant) inferences, such as, "A hunting ape, a killer ape, was in the making" (p. 21). As a mechanism for survival, killing is neither unique nor peculiar in the animal kingdom. However, in our humanized status, our culture attempts to minimize "murder." Our "killer instinct" is well known, but to constantly "glorify" it as the basic nature of man and to indicate that there is little that can be done about it seems to do some disservice to man's concept of law and order. Is the fulfillment of a basic animal desire to be considered a valid defense in a trial? Again, in a similar vein, Morris raps his reader for "forgetting that beneath the surface gloss he is still very much a primate" (p. 23). Does a wise old owl have to remind himself every morning that he's a bird of prey?

The author has a somewhat Freudian, and often teleological, approach to many innocent activities and ana-

tomical structures. For example, the development of "more sensitive hands has given us much greater scope for sexually stimulating body-to-body contacts," and he sees in the evolution of "the protuberant, fleshy nose of our species" a curious relationship with the "spongy erectile tissue that leads to nasal enlargement and nostril expansion by vaso-congestion during sexual arousal." This is hardly a common feature of the sex drive necessitating structural mutation. What of the proboscis monkey? He ignores the evolution of the sense of smell. Another, of numerous examples, is to reduce the estheticism of television, screen, and stage acting to satisfying "voyeurism, using the term in its broadest sense."

The author's attempts to startle and dismay the reader by his interpretations are, in a sense, stimulating and often thought provoking, but he must be taken to task for anatomical and physiological nonsense. A zoologist has easy access to source references that the lay reader does not. Consequently he should do justice to accuracy. Of many examples, glaringly fallacious is his version of the "purpose" of so-called delayed orgasm in human females. He states (p. 78), "When a female monkey has been inseminated by a male, she can wander away without any fear of losing the seminal fluid that now lies in the innermost part of her vaginal tract. She walks on all fours. . . . If a female of our own species were so unmoved by the experience of copulation that she too was likely to get up and wander off immediately afterwards, the situation would be different, for she walks bipedally and the angle of her vaginal passage during normal locomotion is almost vertical." He notes that by gravity this would lead to loss of seminal fluid, and therefore there is great advantage to the female remaining horizontal after the male ejaculates. This is most misleading because the vagina is not a hollow, solid tube but has walls that tend to adhere to each other, and furthermore, spermatozoa are inveterate upstream swimmers and only one need reach its destination to assure successful fertilization. On page 74, too, he develops a peculiar teleological causation for the structural composition of the female genital tract without considering the evolution of the pelvis as a birth canal.

Although reproductive success is an important aspect of evolution, the reviewer finds it difficult to comprehend the devotion of about 50 pages out of the total 241 of text to a chapter on sex (and there are many other references dispersed throughout the rest of the book), and specifically to the phenomenally detailed description of human copulation. It does not seem to have important relevance to the theme of the book. Virtually no other physiological sequences are outlined. Such remarkable developments as the functions of the human hand in relation to its environment are absent from this "zoologist's study of the human animal," as the book is subtitled. Then there are such important announcements as the human "male has the largest penis of any primate" (p. 79), discussion of which seems of little consequence. The size of his brain is scarcely mentioned. There are descriptions and throwback-type interpretations of laughing, crying, babies' sitting, standing, and so on. Some of this is interesting, while some is of psychiatric value.

It is not possible either to tackle all the controversial aspects of this book in a reasonable amount of space—I have made some 20 pages of notes while reading—or to single out for special attention the sweeping generalizations and prognostications that many readers will unfortunately misread as authentic statements rather than as speculations. For example, that man is a neotenic hangover of evolution; that "only" children, "if they do manage to become parents, will make bad ones"; that rhythmic whipping of schoolboys by teachers replaces the pelvic thrusts of the dominant male ("performing an ancient primate form of ritual copulation with their pupils," p. 168); that pregnancy is precluded in a lactating mother ("Suckling is sometimes deliberately prolonged . . . as a contraceptive technique," p. 104); that the colicky baby, in the first three months of life, is actually a reaction to an agitated mother (p. 120), and so forth.

The author adopts various authoritative guises, not the least of which is that of evolutionary and peace counselor: "the best solution for ensuring world peace is the widespread promotion of contraception or abortion."

There is repeated confusion between "society" and "species"; and in his first chapter, "Origins," there is neither clarity of perspective regarding the sequence of events leading to modern man, nor is there substantive evidence for some assertions, for example, "His [the naked ape's] whole body, his way of life, was geared to a forest existence. . . ." (p. 24).

In conclusion, the author has provided the reader with some sort of psychiatric mirror that reflects his motivations in ancestral flashbacks. He has introduced some novel and challenging ideas and speculations. Various aspects will appeal to certain readers, others will be amused, others annoyed, and others satisfied.

I believe that a more accurate subtitle could be "speculations on man's ethos based on the studies of other animals."

RONALD SINGER
University of Chicago

THE NAKED APE—A British View

The biggest stumbling block to Everyman's understanding of the animal world is his tendency to anthropomorphize. So it is ironic, as well as interesting, that by far the most popular natural history book to be published in Britain during 1967, *The Naked Ape* by Desmond Morris, should turn all this on its head. But it does: the author flatly considers man as an animal—or, more particularly, as just another primate—for the purposes of his book.

Dr. Morris, a shrewd and witty performer on typewriter and television, aims to make us see ourselves as "others" might see us, and the fun is pretty furious. His title gives a clue to his mode of thought. Suppose, he suggests, that he were presented with a specimen of man as an unknown species. The feature of this mysterious animal that would strike him most forcibly would be the baldness of its body compared with those of the other primates. Hence, the naked ape.

The technique of considering man purely as an animal—"therionising" us, as one reviewer had it—has its disadvantages. For one thing, it seems to lead the author to ignore, more or less, both our ability to reason and also our rich inner life of fantasy, though these have clearly had considerable influence on the final format of *Homo sapiens.* With the other primates, even if these qualities exist in any definite measure, it may be viable scientifically to discount them; to do so in consideration of the biology of man must lead to a pretty incomplete picture.

However, the Morris technique is undeniably effective in helping us to reappraise the most common aspects of human life—simply because he presents them in such an unfamiliar way. It has been said of the book that the simple account Dr. Morris gives of what human beings actually do when they make love is "recommended reading for children and celibates who have never experienced sexual intercourse, but virtually obligatory reading for those who have experienced it—to the point of losing track of their own actions."

From this point of view and as an aside, *The Naked Ape* has appeared in Britain at an interesting time. Perhaps it could become a useful social antidote, in the sense of bringing meaning once more to actions that have become meaningless in the sexy-permissive, swinging Britain of the late 1960's. But

that is just an idea of mine, and it certainly does not account for the book's runaway popularity. The newspapers, television programs, and so on, that have featured it have done so precisely because they expect its outspokenness to excite, and they have not been disappointed.

No fault lies with the good Doctor though. His book is full of brilliant insights, usually the author's own, and he is nowhere better than in his chapter on sex. We are, he tells us, the "sexiest primate alive," a fact that led to the need for social co-operation and a more lasting system of exclusive sexual pairing than that of the other primates. Our interest in the identity of the other partner brought about frontal coition rather than the posterior kind. And to set us right, Dr. Morris suggests, the original significance of the buttocks and labia as sex signals partially shifted to the rounded female breasts and red lips.

He poses other questions also. Does, for example, the importance of the mother's heartbeat to the unborn child extend into our later behavior so that we cradle infants at the left because the sound of the heartbeat has a calming effect? Again, does our lack of hair, combined with our intense response to contact, boost our interest in inanimate textures?

Dr. Morris has written a lively and provocative book, and I for one am happy to forget its limitations in return for this new, if incomplete, view of myself.

Peter Williams
British Writer and Editor

The Apes, by Vernon Reynolds. *E. P. Dutton & Co., $10.00; 296 pp., illus.*

The current burst of scientific interest in primates has two faces. Biomedical research having found that the manlike apes make serviceable surrogates for man, even as sources of organs for transplanting, has significantly compounded the threat to their continued survival as species. At the same time the increased attention given them by ethologists and ecologists has served to focus world attention on their dwindling numbers. Before any effective action can be taken to avert the inevitable extinction of gorilla, orang, and chimpanzee we must know the biological needs of these species, and we *are* learning them, rapidly.

The Apes is a fascinating compendium of much that is known about these creatures, put together, thank heaven, by a literate zoologist, who has leavened the body of observations made by others with his own field studies of chimpanzees. Dr. Reynolds traces the history of man's knowledge of the apes,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from concepts grounded more in mythology than in fact, through the slow displacement of myth with truth. The book provides a compact resume of what is known about apes in captivity, particularly of their mental capabilities, and of the recent discoveries of the behavior and biology of apes in the wild. The author's criticism of traditional zoo methods of ape-keeping is, unfortunately, largely valid, although some zoos are beginning to meet the apes' needs today, thanks in great part to the new knowledge coming from field studies.

If faults exist in *The Apes*, they are comparatively minor. In some areas the book is up to date, while in others information is no newer than four or five years old. A 1965 British ban on importing orangs is cited, for example, while the author seems unaware that most American zoos have for several years honored a voluntary ban of a similar nature, or that about a year ago the federal government began to enforce in earnest a law that will have the same effect. I was disappointed by several references to the "yeti" as a possible new kind of ape. Although Dr. Reynolds qualifies his remarks, such seemingly credulous comments would better be left to private conversation. This sort of nit-picking, however, is more appropriate to a chimpanzee than to a reviewer, and I can recommend *The Apes* as a readable, balanced treatment on our closest relatives.

JOSEPH A. DAVIS, JR.
New York Zoological Park

Communicating With a Chimpanzee

The human species is distinguished by its ability to use language—a systematic method of communication. But does this preclude the possibility of establishing a communication system with a chimpanzee? An exploratory project of this kind has been reported from the University of Nevada. There, since July, 1966, work has been under way to teach American Sign Language—the standard system of gestures used by deaf persons in North America—to Washoe, an infant female chimpanzee.

Previous attempts elsewhere to teach language to chimps have used vocal communication and yielded very meager results. The current project's investigators, Drs. R. Allen and Beatrice T. Gardner, a husband-wife team of psychologists, reasoned that the explanation might be that vocalization is inappropriate for a species that vocalizes seldom and then only in highly emotional situations. Consequently, in all communication with Washoe, and while communicating with each other in the chimp's presence, the Nevada researchers have restricted themselves to the gesture language.

By December, 1967, when Washoe was estimated to be two and a half years old, her vocabulary had grown to more than 20 signs. Most of the earlier ones she acquired were demands, such as "come-gimme," "more," and "tickle." The more recently acquired signs include names of objects, such as "dog" and "flower."

THE EVER-CHANGING SEA, by David B. Ericson and Goesta Wollin. *Alfred A. Knopf, $7.95; 354 pp., illus.*

This is the second oceanographic volume by David Ericson and Goesta Wollin. Like the first, *The Deep and the Past*, it deals principally with their own research and as a result has a sense of timeliness and personal experience. Happily, *The Ever-Changing Sea* is in many ways a better book than its predecessor. It is broader in scope, better written, and contains much more of the dynamic spirit of today's oceanography. Beginning with a discussion of the sea's scope, following through its circulation and waves to the physical geology, the authors move into the area of their greatest interest, the sedimentary carpet of the ocean floor. From this they proceed to the story of the Pleistocene Ice Age and its effect upon the oceans and the life within them. In dealing with the structural floor of the oceans, an area presently the subject of controversy, they present what might be called the "Lamont viewpoint," giving it one of its best popular expositions. A discussion of the Mohole Project and its importance to acquisition of knowledge of the ocean bottoms is quite relevant, although the project itself has met an untimely death. A penultimate chapter, "Life in Great Depths," seems almost an afterthought, an example of the "gee whiz" school of oceanographic writing. The final chapter, dealing with the ocean and its future, contains much that has been said before but presumably must be said yet another time.

The authors, both oceanographers at Columbia University's Lamont Geological Observatory, bring warmth to the subject of oceanography as they relate anecdotes and personal experiences. However, the unwary reader could be led to believe that little oceanography exists outside Lamont, and certainly that it is *the* outstanding oceanographic institution. While there is undoubtedly some basis for this viewpoint, much of note that has occurred elsewhere does not find its way into this book. One is also led to wonder if the writers pursued their academic careers during the early 30's, for it is in this period that dated anecdotes, events, and people are dealt

with in greatest detail. All chapters have excellent historical perspective, and the reader is shown much of the development of oceanographic hardware and thought. The book is marred in sections by a pedestrian prose that makes it read like a college text. This is unfortunate, for the content is in many ways extremely exciting.

The authors are at their best when they are discussing the present concepts of the dynamic ocean floor in which both the crust and the sediment carpet are in a long-range but nonetheless continuous state of modification.

For persons interested in the sea, *The Ever-Changing Sea* is recommended; it should be read now while it is current, and it should be kept for comparison with books that will be written in the coming years to see how rapidly this field of science is evolving. Most importantly, it should be read by amateurs for it is written by people who are participating in the development of thought concerning the ocean, not secondhand by writers absorbing their information from the published literature. It is this fact that gives the book its most commendable value—contemporaneity.

DONALD SQUIRES
Smithsonian Institution

FRANK M. CHAPMAN IN FLORIDA, compiled and edited by Elisabeth S. Austin. *University of Florida Press, $7.95; 228 pp.*

The text of this book shows us the "ore" out of which ornithology and ornithologists were smelted in the late nineteenth century. It comprises the field notes, letters, and penned reports of Dr. Frank M. Chapman, who for well over fifty years directed the study and exhibition of birds at The American Museum of Natural History.

The publication of Chapman's *Handbook of Birds of Eastern North America* (1895) marked the advent of portable volumes that enable lovers of nature to name the subjects of their interest afield, alive and free rather than reduced to possession as "specimens." More than that, and more than is encompassed by the newer, somewhat staccato and diagrammatic guides to identification, the *Handbook* includes a lively, informative, yet extraordinarily terse biography of every bird. Each such account, indeed, is an admirable life history in minuscule, each a word portrait of the appearance, habits, and personality of every species discussed.

Such aptness can spring only from alert observation, recorded moment by moment. My immediate discovery when reading Mrs. Austin's resurrection of the young Chapman's jottings, beginning with the year 1886, was that here we find a main source of the *Handbook*, not only of its ornithological substance but even of the very phrases, sentences, and longer passages that were to be organized within a decade into a work that set a wholly new standard.

The grist from these notebooks and letters extends, indeed, far beyond the dates of the *Handbook* and its revisions. Throughout the publications of Dr. Chapman, which continued voluminously until 1943, we can find bright flashes from the thoughts he had scribbled in Florida, "hot off the bat," from the age of twenty-two onward. His pages are filled with *beginnings.*

The whole picture of then relatively primitive Florida in this book is one of the allure and charm of a near-tropical environment that was quite exotic to most contemporary Americans. It reflects also the history of slowly changing public sentiment regarding natural resources (too little and too late in many instances). The Carolina parakeet was just going out for ever, the ivory-bill was already on the way, and egret plumes were worth twice their weight in gold. Chapman began, perforce, as a museum collector in a new terrain, but his bent as watcher of living creatures, and ultimately as field experimenter, continually grew. His association with colleagues, either younger or older than he, are made delightfully available. "T. Gilbert Pearson, Field Ornithologist and Oölogist. Nests and eggs collected and exchanged," according to his boyish letterhead of 1894, was a far cry from the Pearson who, as head of the National Audubon Society, wrote *Adventures in Bird Protection.*

Possibly the book may not prove as thoroughly nostalgic to every reader as it has to me. But naturalists in general will recognize it as a precious human and scientific document rescued from oblivion. It includes the complete bibliography of Frank M. Chapman and ends appropriately with a useful chapter on the ornithology of the Gainesville area "then and now" by the editor's husband, Dr. Oliver L. Austin, Jr.

ROBERT CUSHMAN MURPHY
The American Museum

Briefly Noted

THE LAROUSSE ENCYCLOPEDIA OF ANIMAL LIFE. *McGraw-Hill Book Co., $25.00; 640 pp., illus.*

Based on *Les Vie des Animaux* by Léon Bertin, this updated, one-volume guide is a survey of the animals of the world from the single-celled protozoans to the primates. The North American species are covered as adequately as the European. With 1,000 photographs and descriptive texts on

both the zoological groups and the individual species, the book provides a wide range of information in convenient form. But much had to be condensed and abbreviated and while this encyclopedia is adequate for home reference, the serious student will use it merely as a first stop.

The Life of Prairies and Plains, by Durward L. Allen. *McGraw-Hill Book Co., $4.95; 232 pp., illus.*

Durward Allen, Professor of Wildlife Management in the Department of Forestry and Conservation at Purdue University, covers an ecological community that has all but disappeared in North America—the grasslands. Profusely illustrated, the book treats varieties of grasslands, the adaptation of its animal life, and its human inhabitants. A number of appendixes offer additional information on protected grasslands, endangered animals, grass identification, etc. This is the eighth volume in "Our Living World of Nature" series.

The Imperial Collection of Audubon Animals. Original text by John James Audubon and the Rev. John Bachman. Edited and with new text by Victor Cahalane. *Hammond Inc., $25.00; 307 pp., illus.*

Built around *The Viviparous Quadrupeds of North America* this volume reproduces the color plates of John James Audubon and his son, John Woodhouse Audubon. Much of the original text by the elder Audubon and the Rev. John Bachman is preserved, and Victor Cahalane has added additional information, rearranged accounts to follow accepted zoological sequence, and updated the life histories of the species. A handsome production.

The Ray Harm Nature Sketchbook, by Ray Harm. *The World Publishing Company, $7.95; 138 pp., illus.*

A season-by-season excursion into the Kentucky forest by a naturalist and wildlife painter. Accompanying the author's drawings and paintings are his comments and observations of the animals he paints, with helpful tips on tracking and observing animals in the wild. Those who are undaunted at having to rise before dawn will be amply rewarded by the variety of wildlife found in the "quiet" woods.

C.B.

This list details the photographer or other source of illustrations, by page.

COVER—Alan Ternes
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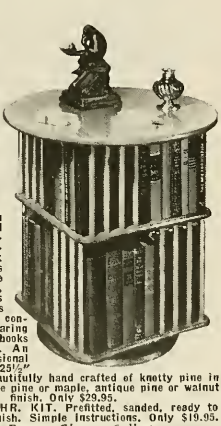

Conformity and Schooling

by Michael Berrill

Every animal, every community of animals, holds a million secrets. Only when you ask the right questions does it reveal any of them, and often the answers can become insights into yourself. Watch an animal, watch it for a long time, and what at first appears senseless gathers meaning.

For many months I have been searching the shallow waters along our coasts for certain small, shrimplike crustaceans. They are called opossum shrimp because each pregnant female carries her young in a ventral brood pouch, but they are properly known as mysids. I have searched in cold waters and in warm, and I have watched the animals in the particular environments in which they live. I have become a part of a quiet world where death has even less drama than on land.

Most mysids are about half an inch long. All are proficient at hiding and at avoiding nets. They are common along the coasts, and I have found different species in abundance from Nova Scotia to the Florida Keys, Jamaica, and California. A mysid is a filter feeder, kicking up a current that it filters for food. It is also a scavenger—grabbing, holding, and eating anything small and immobile enough. It is itself food for the many small fish of the inshore waters. An animal must feed to grow and reproduce, must reproduce to perpetuate the species, and must defend itself from its predators so that it can feed and grow and reproduce. Mysids are unaggressive. They cannot harm or scare their predators. They have been my teachers, instructing me in ways of hiding, teaching me the necessity of conformity.

The rocky coast of Maine is the home of many species of mysids. This is the coast of bays and inlets, of rocks laden with seaweed, of ten-foot tides, of waves crashing on the exposed points. The mysids avoid the crashing waves. They live in protected spots where waves lap the edges of the shore, gently swaying the seaweed.

One of these several mysid species lives near and among the seaweed. It is large by mysid standards, often longer than an inch. It changes its color according to its background, becoming so translucent in clear water against a light background that all you see are its two large eyes and its gut. Ordinarily, however, it is surrounded by dark-brown seaweed, and its chromatophores expand to make it appear equally dark.

It spends its days hovering close to the seaweed, suspended in the water, looking as if it were standing on its tail. When waves rock the seaweed, the mysid lets itself be rocked by the waves. Dark, passively swaying, hovering near the vertical strands of the weed, it is difficult to distinguish. When it is threatened by some nearby disturbance, it jackknifes its body and in a fraction of a second spurts inches away in among the seaweed where it is no longer visible and where fish are not likely to follow. It often clings to the weed instead of hovering in the water. It is a solitary, independent animal.

This then is one answer, one way to hide. Look like your environment, move as your environment moves, even cling to part of your environment, and your predators may not see you. Just don't stand out.

Another mysid species lives off the famous beaches of Cape Cod. It is a lovely little animal, less than half an

Michael Berrill is a Canadian who is now a doctoral candidate at Princeton. His thesis topic is shrimp schooling.

Announcing the first Natural History magazine

Photographic Competition and Exhibition

Grand Prize

Passage to India

A round-trip air fare for two to Delhi

1st Prize for color and 1st Prize for black and white

A Naturalist's Library

Prizewinners and selected honorable mentions will be placed on exhibition in a special gallery adjoining the Akeley Hall of The American Museum. All photographs exhibited will become part of the Museum's permanent collection. Winners and honorable mentions will be announced in the June-July issue of NATURAL HISTORY. In addition, a selection of the winning photographs will be published.

Photographs submitted should illustrate the following theme:

In nature's infinite book of secrecy
A little I can read.
Shakespeare, *Antony and Cleopatra*

The Judges:

GORDON REEKIE, *Director of Exhibition*
The American Museum of Natural History

PATRICIA CAULFIELD, *Photography Columnist*
NATURAL HISTORY

JACOB DESCHIN, *Editor*
The New York Times

DAVID BROWER, *Executive Director*
Sierra Club

ARTHUR ROTHSTEIN, *Director of Photography*
Look

DEADLINE FOR ENTRIES: March 15, 1968

MAIL TO: Photographic Contest
NATURAL HISTORY Magazine, 7 West 77th St., N.Y., N.Y. 10024

COMPETITION RULES:

1. The contest is strictly for amateur photographers. Anyone is eligible except employees of NATURAL HISTORY or of The American Museum of Natural History, members of their families, and individuals who personally, or any members of whose families, are engaged in the manufacture, sale, commercial finishing, or professional use of photographic goods.

2. No negatives should be submitted. Entries must be postmarked no later than March 15, 1968. IMPORTANT: No more than two pictures may be submitted by any one entrant.

3. Color photographs:
   a. Color pictures may be submitted as either a transparency or a print. Do not submit both a transparency and print of the same picture.
   b. Transparencies must be originals and must be mounted in cardboard only.

4. All prints (color and black and white) must be approximately 8x10 and unmounted.

5. General:
   a. On the back of the photograph or on the transparency mount *must* appear: name and address of photographer, make of camera used in taking the picture, and the place it was shot.
   b. Developing and printing may be done by a photofinisher or by the entrant. No composite picture, such as multiple printing, multiple exposure, or montage, is eligible. No artwork or retouching on prints or negatives is permitted.
   c. All color transparencies will be returned to entrant only if accompanied by a self-addressed envelope of proper size, bearing sufficient return postage. Black-and-white prints will *not* be returned.

6. NATURAL HISTORY assumes no responsibility for prints or transparencies.

7. Pictures will be judged on photographic quality and originality in treatment of the theme. The decision of the judges will be final.

8. Before receiving a final prize, the entrant must sign a statement that his picture, or any closely similar picture of his of the same subject or situation, has not been, and will not be, offered for publication in any manner prior to July 1, 1968. NATURAL HISTORY retains first publication rights to winning pictures.

PRIZES:

Grand Prize: For the best color *or* black-and-white entry NATURAL HISTORY will provide a round-trip for two to Delhi.

1st Prize color, 1st Prize black and white: A Naturalist's Library: a 50-volume collection selected by Hal Borland, based on the books mentioned in his essay in the January, 1968, issue of NATURAL HISTORY.

Honorable Mention: In addition to the prizewinning entries, photographs selected by the judges for honorable mention will be mounted for a special exhibition in the gallery adjoining Akeley Hall in The American Museum of Natural History.

inch long and strikingly red around its eyes, brood pouch, and tail joint. It usually lives in the deeper water of twenty feet or more where rubble gathers in certain places on the sea floor. The intact shells of common surf clams often accumulate in this rubble, lying slightly agape although no longer inhabited by their original owners. These become the daytime homes of the little red mysid.

The mysid does not hide in the clamshells to the exclusion of all other objects. It hides under anything. But the barely open clamshell is the perfect hiding site; most such shells have from two or three to a hundred individuals inside them throughout the day. The animals rarely leave their hiding places in daylight. They seldom jostle or disturb one another. If one, for some reason, leaves its shell, it turns tail immediately and rather frantically speeds back in again.

When night comes the mysid becomes active. It leaves its protecting shell and cruises around on the bottom foraging for food. Now its redness does not matter, for there is no light to make it look red. In fact, red is not an uncommon color for nocturnal crustaceans, possibly because red pigment is more easily produced than its alternatives and so occurs often where color adaptation is not important. In any case, with the coming of dawn the small mysids hide in and under shells once again to wait out the daylight hours.

This is another answer, quite different from that of mimicking your environment. Instead, hide where you can't be seen during the hours when your predators are feeding, and at night when your predators are quiet you can leave your hiding place and go out and eat.

Another change of scene and another mysid. This time imagine a coral reef beside a small island not far from the southern shore of Jamaica. The water is Caribbean blue; the corals and their associated fish are here and they are spectacular. Not the best of reefs, but still beautiful. The wave surge is strong, and each wave sweeps everything not attached to the coral or sand back and forth as it passes by. Swimming here is not easy, for if you relax, the surge of the waves soon thrusts you onto the corals or into a cluster of purple, long-spined sea urchins whose spines break off to penetrate and poison whatever touches them.

These sea urchins are safe from predation since no animal hurts itself on purpose. Occasionally a swarm of perhaps a thousand small, white, translucent mysids sweeps back and forth with the wave surge over a cluster of two or three of the urchins. The mysids orient and swim against each surge direction, always staying within a foot or two of the cluster. At the least disturbance they dive as a group in among the spines of the urchins where they are completely safe. When the disturbance ceases, they swarm once again over the urchins.

These mysids can school in the way that many fish school. They can swim as an oriented group, responding as a unit, yet leaderless and lacking any division of labor within the group. What a far cry from the often solitary, hovering mysid in Maine or the quiet aggregations of the red mysids in the empty clamshells off Cape Cod. Yet once again this is an animal colored to draw least attention to itself, hiding when it must in the best

hiding places the environment has.

Schooling behavior is intriguing in itself, for it brings individuals together, and you might expect them to be more easily seen and susceptible to predation than if they remained separate. Schooling, however, may not be such a bad defense. If each individual is concerned only with saving its own skin, then as a member of a school it may not be taking such a risk. It may mimic the avoidance movements of other individuals and so avoid a predator before actually seeing it. It may hide in the school, for only those on the edge of the school are near possible predators.

Most of all, though, as one of a group, whose members all look identical and are in constant motion, it may confuse the predator. This is more than hypothesis. Any predator that must zero in on a single prey would be confused by a group of moving individuals. You need only play the part of the predator and try to catch a single fish of a fish school, or for that matter a single mysid of a mysid school, to discover how complete the confusion can be.

Other mysids school in other environments. Several species school in and near the surf zone of the California beaches where they have no place to hide except among themselves. Another schools in vast numbers along the edges of lagoons of the Jamaican mangroves. Each school has only one size of individual in it. Juveniles school with juveniles, adults with adults. This happens partly because the juveniles cannot keep up with the adults or fight waves or currents as strong as those the adults successfully fight. It happens partly because adults attack juveniles as potential food and so chase them from the adult school. The result, no matter what the reasons, is that like schools with like. No one in a school looks or behaves any differently from all the others. No one stands out.

I have spoken of mysids because I know them well. Practically any animal would have made an equally good example. Animals have evolved many ways of hiding themselves and many ways of conforming to their particular environments so that they are not easily seen. They conform in rhythm, movement, size, shape, color, in mimicking their environment or mimicking themselves. Any animal that does not conform is likely to be the one that is eaten. Often this nonconformity appears in the form of sickness or injury, making an animal conspicuous by its slowness or erratic behavior, and that is the animal the predator catches most easily.

Predation enforces conformity. Without predator pressure, animals could have far greater individual expression. What about ourselves? We conform in so many of the same ways. We modify our appearance, our habits, our actions, our opinions so as not to stand out. We conform all the time and we all know this. We have no predators now to detect and destroy the nonconformer. We have, however, substituted cultural pressure for predation. We have, in a way, become our own predators.

Two mysid shrimp swim in the waters off Jamaica. A male is at top and a pregnant female below.

Suggested Additional Reading

PROSPERITY AND THE NATIONAL PARKS

DAMS AND WILD RIVERS. L. J. Carter. *Science*, Vol. 158, No. 3798, 1967.

OVER-USE OF THE NATIONAL PARKS. W. A. Johnson. *National Parks Magazine*, October, 1967.

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ENVIRONMENT AND ARCHAEOLOGY. K. W. Butzer. Aldine Publishing Co., Chicago, 1964.

THE HUNT OF THE WASPS AT JACKSON HOLE

CURIOUS NATURALISTS. N. Tinbergen. Basic Books, New York, 1958.

PARALYSIS CAUSED BY THE DIGGER-WASP PHILANTHUS. W. Rathmayer. *Nature*, Vol. 196, pp. 1148-1151, 1962.

PREDATORY WASPS. H. E. Evans. *Scientific American*, April, 1963.

CHIPPING STONES IN THE OUTBACK

THE WORLD OF THE FIRST AUSTRALIANS. R. M. and C. H. Berndt. Ure Smith Pty., Ltd., Sydney, Australia, 1964.

THE PREHISTORY OF THE AUSTRALIAN ABORIGINE. D. J. Mulvaney. *Scientific American*, March, 1966.

MAN THE TOOL MAKER. K. P. Oakley. University of Chicago Press, Chicago, 1957.

THE TURTLE GRASS COMMUNITY

THE EDGE OF THE SEA. R. Carson. The New American Library, New York, 1959.

THE LOWER ANIMALS. R. Buchsbaum and L. J. Milne. Doubleday & Co., Inc., Garden City, 1960.

BETWEEN PACIFIC TIDES. E. F. Ricketts and J. Calvin. Stanford University Press, Stanford, 1952.

THE EVOLUTION OF DUCK COURTSHIP

INHERITANCE OF BEHAVIORAL CHARACTERS IN F_2 MALLARD X PINTAIL (*Anas platyrhynchos* L. x *Anas acuta* L.) HYBRIDS. R. S. Sharpe and P. A. Johnsgard. *Behaviour*, Vol. 26, pp. 259-272, 1966.

THE EVOLUTION OF BEHAVIOR. K. Z. Lorenz. *Scientific American*, December, 1958.

COURTSHIP: AN ETHOLOGICAL STUDY. M. Bastock. Aldine Publishing Co., Chicago, 1967.

Get away to it all

Alaska. It's all too much to tell in one ad. But here's one example of how to make your getaway: drive aboard one of the State's modern ferryliners at Prince Rupert, British Columbia. Start your cruise up the famed 'Inside Passage'—early explorer and gold-rush route. See scenery that has to be called super-spectacular. You'll slip by glaciers crushing to the sea. High forested mountains plunge to deep fjords. Around the bend, there's a fishing village or a surprised whale. Deer and bear watch you go by. The weather's warm.

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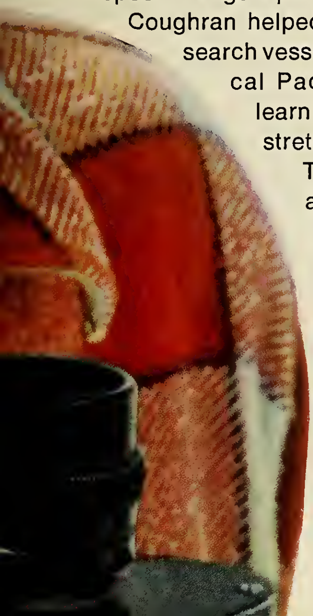

Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. LXXVII No. 3 March 1968

DEPARTMENTS

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NATURAL HISTORY *is ind in* Reader's Guide to Periodical Literature.

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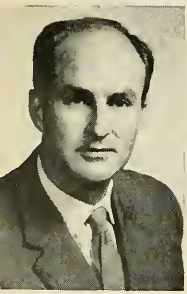

O. C. Farquhar

W. M. S. Russell

Author of "Nature and the City," AUGUST HECKSCHER is the Commissioner of Parks in the city of New York. Prior to assuming this position, Mr. Heckscher served as director of the Twentieth Century Fund, as special consultant on the arts to President Kennedy, and in a number of public service positions. He holds degrees from Yale and Harvard and honorary degrees from the Regents of the University of New York State, from C. W. Post College, and from Fairleigh Dickinson, Temple, and Brandeis Universities. Mr. Heckscher is an accomplished author and editor, having served for some years as the chief editorial writer for the *New York Herald Tribune*.

Although his articles on nature and the natural environment regularly appear in most of the country's leading magazines, JOSEPH WOOD KRUTCH describes himself as an "amateur" naturalist. He lives in Tucson, and is now an acknowledged expert on desert life. Nature writing and studying the desert environment have become his latest career. Dr. Krutch was formerly Professor of Dramatic Literature at Columbia, and has written such distinguished books as *The Modern Temper*, *The Great Chain of Life*, and *The Measure of Man*.

A former director of Educational Services, Inc., an organization devoted to curriculum development, DAVID WEBSTER is a regular contributor to *Nature and Science* magazine and a writer of science books for young people. Mr. Webster is also a science teacher, and is currently working on a book about snow, to be published later this year by Natural History Press.

THOMAS M. GRIFFITHS (known to his associates as Mel) is Professor and Chairman of the Department of Geography at the University of Denver. In his article, Dr. Griffiths deals with the narrow band of earth and air from about six feet above to several feet below our planet's surface—the province of the microclimatologist. In addition to his teaching and research, Dr. Griffiths has contrib uted to the *Encyclopaedia Britannicc* and has written numerous magazin articles.

In order to photograph muskoxen author-photographer FRED BRUEM MER traveled some 1.200 miles b dog sled, accompanying a group o Eskimos on a six-week trip in th spring of 1967. Some of these photo graphs appear in his article, "Il Shapen Beast." He had formerl studied the muskox on Spitsbergen an island group near Norway. Th author worked for Canadian news papers prior to turning to free-lanc writing and photography. His firs article for NATURAL HISTORY ("Sabl Island") appeared in the August September, 1967, issue.

This month, ALAN TERNES contrib utes his second article in a two-par series on Ethiopia. The author's fa miliarity with Ethiopia is the resul of his travels in that country durin the summer of 1967, and of his stud ies with the African geographer Wi liam Hance, at Columbia Universit

Geologist O. C. FARQUHAR is a pro fessor at the University of Massachu setts in Amherst. He has performe field work in geology in North Ame ica, Africa, and New Zealand. In hi article, "Enigma on the Sea Floor, Dr. Farquhar departs from his pr mary interests, engineering geolog and mineral deposits, to discuss th animal-made trails found on th ocean floor.

Author of "The Slash-and-Bur Technique," W. M. S. RUSSELL is member of the Department of Socio ogy at the University of Reading i England, where he lectures on soci biology. Russell has made many ap pearances on British television an radio. In addition to writing fictio the author has published several ma azine articles and books in the fiel of endocrinology, evolutionary th ory, and animal and human beha ior. He is currently at work on a boo dealing with aggression in anima and man.

Nature and the City

August Heckscher, New York City Parks Commissioner, comments on the urban parks—a setting for recreation, a contribution to the city's esthetic dimensions, but most importantly, a reminder that our lives are very much a part of nature

My feelings for the natural world do not derive from professional experience as a naturalist. I can lay no claim to the role of botanist or zoologist, of horticulturist or ornithologist. I am more, I suppose, a philosopher who came to believe quite long ago that to live in close contact with nature is the surest way to the happiness and wisdom of a full life. This is a very old ideal, a characteristic strain in Western civilization from Socrates to Montesquieu, and to our own Thoreau. It has much to do with the world of natural things, but it goes deeper to affirm that man cannot escape from his own origins, that he must know himself, and that to know himself he must recognize that he is part of the mysterious web of organic and inorganic nature.

When man tries to separate himself from this web he rises not to new heights or a truer wisdom, but ascends at best to the nightmares of reason. Montesquieu speaks somewhere of "celestial thoughts and subterranean conduct." It is a chilling, bitter phrase, but it says something important about man and his fate.

In the past it has perhaps been easiest to attain wisdom and humility in the context of a rural existence. To be close to earth and to the changing seasons, to be in some measure one with growing things, is to be healthily reminded of one's human limitations.

I recall some years ago crossing over into the state of Vermont; at the first crossroads where I stopped to ask the way, I remarked on the fact

Jamaica Bay Wildlife Refuge, part of the New York City park system.

hat it was a beautiful day. The Vermonter looked at me quite a while, hen he said, "Yes, we've known a ew." The subtle rebuke to my enhusiasm, but even more, the feeling of that man's rootedness in the times ind seasons, has always remained vith me. The days that he had really nown, really lived, had kept him iuman, as I like to think they had nade him wise.

In modern life we have gone to the opposite extreme. The heresy of the ige is man's arrogance in putting iimself above nature, literally outide of it, as he seeks to control and exploit it for his own uses. Never beore has it been possible for man to nake over entire environments. But he power to make over is the power o destroy the environment upon vhich all life—including man's—depends. It is no longer a question of vhether or not we shall change the ace of the planet. But it is a deep ind disconcerting question whether ve shall change it so radically, so ireversibly, as to disorganize the processes by which life in all its manioldness is sustained and renewed. To heedlessly promote or condone he extinction of a growing number of plant and animal species, to begin o make over man's psyche, his body, ind, indeed, to tamper with his genes s to stand in a new and terrifying elationship to nature.

A saving instinct may neverthe-ess be at work. Lewis Mumford in *The Myth of the Machine*, a recent study of profound significance, has suggested that this heresy has in fact leveloped comparatively recently, ind that it may be reversed and outived. We have read the history of our race, he argues, in terms of toolmaking—we have measured man's progress by his capacity to change outward things. But the reconstruction of history and anthropology appears to lead to another conclusion: that man has always sought self-expression above domination; that he has been primarily the seeker and finder rather than the exploiter. If this is true, then we may yet be rescued by our better selves, and a balance may be established between the appetites of men and the physical limitations of the environment.

We shall be prudent, in any case, to the extent that we preserve nature and study its ways; and the midst of a great city is as appropriate a location as any other in which to do this. As Parks Commissioner I have been keenly aware of the responsibility to see that within the gray city of stone and steel there survives a green city accessible to all the citizens. It is sometimes a discouraging task. One looks about at the vast manifestations of the urban scene, the masses of men, the monstrously piled up structures; one remembers Keats' youthful, jubilant lines:

> To one who has been long in city pent,
> 'Tis very sweet to look into the fair
> And open face of heaven—to breathe a prayer
> Full in the smile of the blue firmament. . . .

Yet Keats, when he felt that release, was only a few miles from the center of the London of his day. He had walked across the heath to find pure air and serene skies. In a far more crowded and difficult environment we must find our own "lair of wavy grass." And we must keep it, notwithstanding the threats that press from all directions.

The parks play many roles in the city of today. They contribute significantly to its esthetic and architectural dimensions, breaking what must otherwise become a homogenized, dull landscape and individualizing the citizen's environment. To live close to a park is to have one's neighborhood defined; it is significant that almost every open space has its organized, and usually vociferous, citizens' group. The parks also provide a setting for recreation and play. More recently they have become in New York the great stage upon which the common values of the community are celebrated, in such strange ways as "happenings" or in the large gatherings at cultural events. But perhaps most importantly, the parks provide the saving reminder that nature is still part of our lives—or, more correctly, that our lives are a part of nature.

New York is fortunate in the wide spaces that have been left to us by earlier generations. Central Park in Manhattan stands as a quiet miracle at the heart of a city seemingly given over to an expression of man's naked power. Not less extraordinary is the green circle of parks carved out in the Bronx before the northward thrust of the city had made itself fully felt. The city is fortunate, too, in the bays, rivers, and seas that surround it—along with their beaches and their vanishing wetlands, a natural resource that is too often unappreciated.

On a gray and windy day last spring, during my first weeks as Parks Commissioner, I sailed out in the motor launch that is the flagship of the Department's navy to explore the bird-populated islands of Jamaica Bay. Another day I stood in a roaring northeaster upon the dramatic outcropping of rock at the point of Pelham Bay Park. On Staten Island, I walked in a light rain through the High Rock nature preserve watching a group of children who had come out of the classroom to learn something of the mystery of a pond's ecology. These experiences represent, for me, some of the more rewarding contacts with the city's natural environment, because these shoreline areas remain relatively unaltered by the hand of man.

And then, on another memorable evening, Mayor Lindsay and I landed by helicopter on the beach at Rockaway. We listened as one of our good park workers explained how our highly prized "beach sanitizer" cleaned the shore so well of all debris, including seashells, that the sands blew away and had to be restored by bringing in a bulldozer. There, indeed, was an example of our ineptitude in attempting to improve upon nature with "management."

A surprising number of natural scenes remain in New York, but the city presses inexorably upon all the open areas. The road builders have already cut across some of our greatest parks, and threaten others. Institutional buildings within or alongside the parks seek, as if by a natural law, to expand. Pollution of earth, air, and water limits the usefulness of the parks and shorefronts. In a frantic search for places to dispose of its ever-mounting wastes, the modern city looks to parks as an inviting, though temporary, expedient.

A few victories, a few hoped for reversals of the current trends, give meaning to the work of a city Parks Commissioner. Soon after I was appointed, a beautiful wetland in the Split Rock section of Pelham Bay Park was slated, under a long-standing plan, to become a dumping place for raw garbage. A million years had gone into the making of that rich, mysterious piece of earth and water; if it were touched now, another million years could not undo the damage. The Mayor, the head of the City Planning Commission, the Commis-

sioner of Sanitation, and I gathered one late spring evening on the spot. The astonishing but highly gratifying outcome of our meeting was that Split Rock should be saved!

The people of the Bronx continue to generate the wastes that are part of contemporary civilization, and we still have not resolved the problem of how these are to be disposed of in the interval before long-range plans can be put into effect. But the wetland is, for now, secure. And soon children from the whole city will be going to a simple nature center there, where they can see and learn of nature's strange workings, and explore a wealth such as few cities possess.

Jamaica Bay is kept as a bird sanctuary, in spite of pressures to give over its tide-washed islands to housing, industry, or mass recreation. The jets of nearby Kennedy Airport have not driven off nature's own fliers, and if the city takes the sensible step of decentralizing its air traffic, birds may still be at home there a generation from now, perhaps several generations hence. The green belt on Staten Island persists precariously, while authorities in Albany and Washington seem unwilling to give final acknowledgment to the supremacy of man's stake in nature over his disposition to build eight-lane expressways. At the tip of the Rockaways, Breezy Point displays the skeletons of half-completed housing projects, halted by court order while men exhibit the good sense to weigh the merits of natural beauty over one more extension of concrete.

Last year, when the poet laureate of England died, it was good to recall his feeling for those small, cherished parts of earth that contain much that is important to man's wholeness and sanity. "Some places," John Masefield had written, "seem to have a memory and a living spirit. We do well to keep such places holy, and to seek what they have to tell us."

In the modern, all-consuming city such locations may be those that mark the journey of a good man or note some other moment in history. But most often they are simple bits of wildness left for us to cherish and keep. What these places have to tell us is important beyond the power of words to convey. On our capacity to listen to the lesson they teach, and truly to understand it, may well depend man's survival on this planet.

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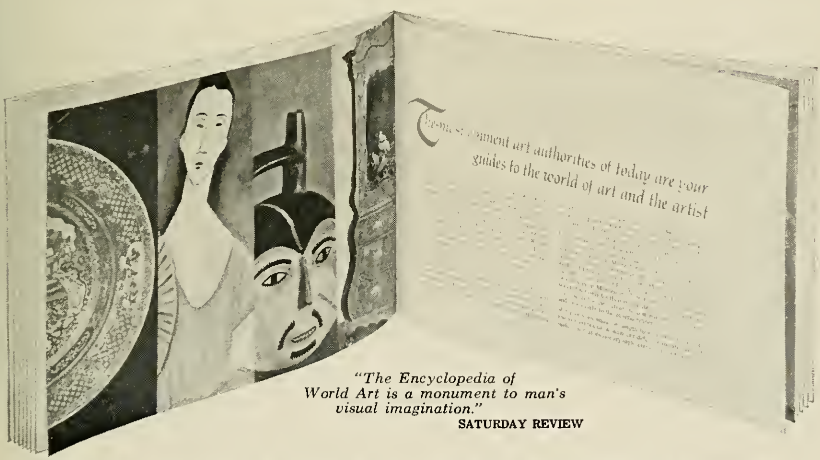

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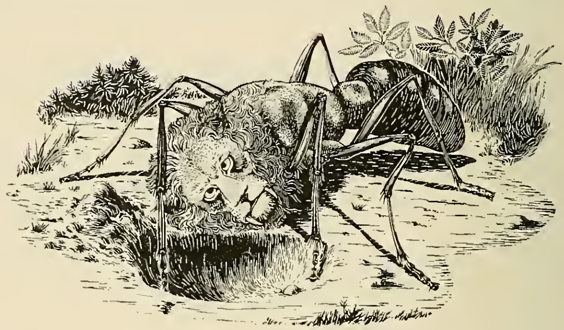
The Unnatural Histo

Two different insects were commonly called doodlebugs a generation or two ago—and for all I know they may be called so still. One is the larva of a tiger beetle and the other the larva of the ant lion. What they have in common is that both lie in pits below the surface of the ground where they wait for their prey to pass by, and where small boys, with fewer amusements than they have today, used to fish for them with straws. The larva of still another unrelated insect, the fly of the genus *Vermileo,* or worm lion, has also somehow or other developed the habit of constructing a pit in which to wait for unlucky passersby.

Only members of the family Myrmeleontidae (the ant lion) concern us here, but there is enough of both natural and unnatural history concerning them to fill a book. The two-part name, ant lion, was certainly responsible for a good deal of the unnatural part, and although this term is an accepted one today, its history goes back a long way to the time when it was applied both to the actual insect and to the fabulous creature its name suggested.

As for the actual insect, nearly everybody in the United States and most parts of Europe who uses his eyes has seen the little conical pit that the ant lion constructs by backing into dry or sandy soil until it is hidden at the bottom of its lair. Anyone who has read a book about insects has learned—even if he has never happened to observe—how the creature prevents the escape of any unlucky ant or other arthropod that has tumbled in by bombarding it with grains of sand or soil, so that it tumbles down the steep sides of the pit where the hollow jaws of the ant lion suck its body juices without letting go of the victim. At this moment there are scores of newly constructed pits ten



"It has the face of a lion and the hinderparts of an ant. Its fathe eats flesh, but its mother grain . . . they then engender the an lion . . . a thing of two natures. . . ."

or twelve feet from my kitchen door, and there must be billions of them scattered over the earth.

The most curious thing about the whole history of the ant lion is the way in which accurate observations got mixed up with moralizing and, worse yet, with extravagant fable. The purpose of this article is to trace the way in which all this came about.

The real ant lion has been known since classical times and was referred to in reasonably accurate terms right on up through the Middle Ages, at the same time that the fabled ant lion was leading an independent existence. You will find the insect even in Aelian, a Roman of the third century A.D., who wrote one of the most unreliable of all books of natural history. You will find him also in many medieval bestiaries and homilies, including a treatise on the Book of Job by Pope Gregory, who wrote:

"The ant lion is a little creature, a foe to ants, which hides itself under the dust and kills the ants laden with corn and devours them when killed. It is rightly called an ant lion becaus with reference to winged creature or any other little animals it is a lio for it devours these like a lion but o the other sort it is devoured like a ant."

It is unlikely that Pope Gregor had any knowledge closer than thir or fourth hand, but what he has t say is accurate enough as natura history, and his explanation of th name is as good as any. But, o course, he was interested in insect or any other less-than-human crea tures only for the sake of the moral that could be drawn from them, an on this topic he lets himself go freely Of the ant lion he writes:

"This same creature . . . signifie the Apostate Angel, who being cas out of Heaven upon the earth, beset the minds of the righteous in the ver pathway of their practice, that i providing themselves with the pro vender of good works; and while h overcomes them by his snares, he a it were kills them by surprise as ant carrying their corn. And like the An

f the Ant Lion

by Joseph Wood Krutch

Lion he is strong to encounter those that yield to him, but is weak against such as resist him."

This small grain of fact with its intolerable deal of morality was passed down the ages and turns up in dozens of later works including that most popular of late medieval encyclopedias *Concerning the Nature of Things,* written in Latin in the thirteenth century and translated in the next. According to its author, Bartholomew of England:

"There is another kind of spider by name Mirmicoleon . . . it is like an ant . . . and it is called ant lion because it hunts ants like a lion and sucks out the juices from their bodies, but is devoured by sparrows and other birds just as an ant."

Some later accounts are further from the truth and, if possible, more farfetched in their moral overtones than Pope Gregory's, but at least a thin trickle of fact about the ant lion did flow down from classical antiquity through the Dark and the Middle Ages until it reached the time when observation began to correct or supplement authority and speculation.

Meanwhile, the fictional ant lion was created in order to rationalize an extraordinary confusion that had sprung up in the minds of those who could not determine the creature's true nature. This fabulous ant lion you may meet fully developed in a Latin bestiary preserved in the Bodleian Library and translated by M. R. James. The relevant passage is as follows:

"Eliphaz the king of the Temanites says, 'The ant lion perished because it had not food.' The Physiologus said: 'It has the face of a lion and the hinderparts of an ant. Its father eats flesh, but its mother grain. If they then engender the ant lion, they engender a thing of two natures, such that it cannot eat flesh because of the nature of its mother, nor grain because of the nature of its father. It perishes, therefore, because it has no nutriment. So is every double minded man, unstable in all his ways.' "

Now, the predicament of this amazing creature (as I am not the first to point out) closely resembles that of the bread-and-butter fly in Lewis Carroll's *Alice,* which, it may be remembered, ought to live on toast and weak tea but in fact, always dies of starvation because it can't find any. How, one wonders, could anyone have come to invent this

The ant lions of India, which were said to mine gold, displayed amazing alacrity when their gold was stolen: ". . . nothing in the world can touch these ants for speed, so not one of the Indians would get home alive, if they did not make sure of a good start while the ants were mustering their forces."

most improbable of all the improbable animals that found a place in the bestiaries.

Eliphaz is, of course, one of Job's comforters. But if one turns to the fourth chapter of the Book of Job from which the passage is derived one will not find anything about an ant lion. Whether one goes to the Hebrew, the Latin Vulgate, the King James, the Revised, or any of the other usual translations or versions, one will find only that Eliphaz (in typical Job-comforting fashion) is merely pointing out that misfortunes come ultimately to all and that even the toothless old lion dies for lack of prey.

How then did the author of the bestiary come to read "ant lion" instead of "lion"? Turn to the ancient Greek translation of the Old Testament known as the Septuagint and you will find that the word actually employed there is *myrmicoleon* not simply *leon* (although none of the translations of the Septuagint that I have been able to find in English translate the word other than—incorrectly—"lion," and only one calls attention in a footnote to the fact that the original Greek text actually does read "ant lion").

But that solves only half of the mystery, for how did the ant lion get into the Greek Septuagint in the first place? There are few clues in the chain of false inferences and factual misstatements that would help to explain this mystery, but one essential fact stands out: *myrmicoleon* was used in Greek to mean either our insect or "lion-ant," which was a huge, dog-sized ant said to live in Arabia and also in India. These "lions" turn up in Herodotus (fifth century B.C.) where they are said to occur in an Indian desert:

"There is found in this desert a kind of ant of great size—bigger than

a fox though not so big as a dog. . . . These creatures as they burrow underground throw up the sand in heaps, just as our own ants throw up the earth, and they are very like ours in shape. The sand has a rich content of gold, and this it is that the Indians are after when they make their expedition into the desert. Each man harnesses three camels abreast, the female on which he rides in the middle and a male on each side in a leading-rein. . . . When the Indians reach the place where the gold is, they fill the bags they have brought with them with the sand, and start for home again as fast as they can go; for the ants (if we may believe the Persian story) smell them and at once give chase: nothing in the world can touch these ants for speed, so not one of the Indians would get home alive, if they did not make sure of a good start while the ants were mustering their forces. The male camels, which are slower movers than the females, soon begin to drag and are left behind, one after the other, while the females are kept going hard by the memory of their young, who were left at home."

Some five centuries later the Greek geographer Strabo takes up the story of what he refers to as "the lions who are called ants," said to mine gold in India.

"In the mountains there is a plateau approximately three thousand stadia in circuit, and below it are gold mines, of which the miners are ants, animals that are no taller than foxes . . . they dig holes in the winter and heap up the earth at the mouths of the holes, like moles, the gold dust requiring but little smelting."

Of another country Strabo writes, "it abounds with elephants and also in lions called ants, which have their genital organs reversed but are less hairy than those in Arabia."

These lion ants are, he says, reported to be spotted like leopards, and it is noticeable that between the time of Herodotus and the time of Strabo the lion ants have become more lionlike. They are, by the way, said to be found in ancient Hindu literature, and they also turn up some centuries after Strabo in the medieval romance of Alexander where they are large enough and fierce enough to carry off both horses and their riders. They are also mentioned in

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the mysterious twelfth-century letter from Prester John to the Pope.

Why the seventy scholars who are supposed to have translated the Hebrew Old Testament into Greek should have translated as "ant lion" a word that, at least in the surviving Hebrew texts, is simply "lion" remains obscure. Since the Hebrew text they used is believed to have been older than the oldest now surviving, it is possible that the term "ant lion," or rather "lion-ant," did in fact appear in the original Hebrew text and was translated correctly by the Greek scholars.

In any case, the last stage of the confusion that created the bread-and-butter fly's cousin is clear. Finding the word "ant lion" and not knowing to what it referred, the writers of bestiaries followed a practice common with them under similar circumstances. They started with the word and imagined an animal that it would fit. An ant lion must, they said to themselves, be half-lion and half-ant. If it was said in the Holy Text to die for lack of food, some superingenious ponderer of this statement evidently concluded that, as the bestiary said, it perished because it could find no suitable food.

This remarkable creature had, no doubt, been totally forgotten by the time men again began to observe even creatures as insignificant as ants and to add to the meager facts reported by the ancients. There is no mention of the ant lion in the *Theater of Insects*, by Dr. Thomas Muffet, printed as a supplement to Topsell's seventeenth-century *History of Four-footed Beasts*, but a mid-eighteenth-century German book gives a good factual account accompanied by a full-page plate, and at about the same time Réaumur's classic description of the ant lion appeared in his *Mémoires pour Servir à l'Histoire des Insectes*. Included in the French text is an elaborate description of the ant lion's habits accompanied by an informative full-page plate. Dr. Muffet, by the way, was especially fond of spiders, and he spends several long paragraphs extolling their virtues. (Presumably he served as the fictional parent of little Miss Muffet—who didn't share her father's taste.)

How can anyone have been silly enough to invent that most improbable of monsters, the half-ant, half-lion, by comparison with which a

centaur or a sphinx sounds quite common?

Actually those who deduced the ant lion from the available evidence weren't necessarily silly at all. Let us imagine a similar situation. Let us imagine that something or other—say a worldwide atomic war—has brought on a new dark age, as dark as that of the seventh century A.D. The few scraps of written history, science, and literature that have survived are pored over by the few still interested in learning, and among the surviving texts are found several references to "bird men." Special reference is made to two of them who were named, respectively, Charles Lindbergh and Roger Tory Peterson. In our day we should perhaps have been more consistent if we had called an ornithologist a "bird man" and an aviator a "man bird," but we did not make the distinction and thus set the stage for a confusion almost as inevitable as that between the ant lion and the lion ant. Let's imagine also that a few comic books have survived, among them one devoted to Batman.

Pondering all these bits of evidence the future equivalent of a monk in his cell might write something like this:

"In the olden days men talked a good deal about a flying animal called a Batman. He had large wings like a bat and he once flew thousands of miles across the ocean. Some authors say that his name was Peterson but others called him Lindbergh."

In all fairness to the compilers of bestiaries, it should be noted that they did very well when describing an animal they had had an opportunity to observe. And in describing animals they had never seen they sometimes included such accurate bits of information that we wonder how they got them. One of the better bestiaries, for instance, contains a description of the elephant that includes, along with the eternal chestnut about its remarkable memory, the statement that its period of gestation is two years—almost precisely correct. The survival in our own society of such indestructible fables as that of the milk snake, the hoop snake, and the deadly mule killer is rather more remarkable than the limitations of the medieval compiler of natural history.

Black, White, Colored

by Marston Bates

We have, in the United States, become burdened with a whole complex of attitudes and beliefs about race that forms a frighteningly explosive mixture. The problems are clearly social rather than biological, arising out of developments in the cultural history of Western civilization as a whole, and of the United States in particular. The solutions will also necessarily involve cultural change. Yet race—geographical variation within an animal species—is a biological phenomenon, which may give me some excuse for contributing to the mass of verbiage that has been generated in the discussion of racial problems.

Our vocabulary annoys me. I find "white" a particularly silly term for peoples of European and Near Eastern origin. Albinos, who may turn up almost anywhere, might be called white; but with that exception I can't see how the word could apply to any human skin. "Of the color of snow or milk" the dictionary says of white. My efforts to imagine a human complexion blending into a snowbank are unavailing. Ermine may be white, but not people. Europeans, when they stay out of the sun, tend to be lighter than most other people; but the best term for this would seem to be "paleface," allegedly used by the American Indians.

There are all sorts of troubles with connotations when we use "white" and "black." One of the subsidiary meanings of "white" is "morally or spiritually pure or stainless"; and the *Oxford English Dictionary* has another subsidiary meaning (7b): "free from malignity or evil intent; beneficent, innocent, harmless, esp. as opposed to something characterized as *black*." We have, for instance, the difference between white magic and black. We of European descent might like to think of ourselves as white in this sense of being innocent and beneficent; but such a belief is hardly held up by history.

The problem was already bothering me back in 1952 when I wrote the chapter on "The Varieties of Tropical Man" in *Where Winter Never Comes*. I suggested there that we might be better off if we used words based on Greek: "leucoderm" for white skin; "melanoderm" for black; "xanthoderm" for yellow; "erythroderm" for red. It would seem to me much more difficult to get upset about leucoderms versus melanoderms than about white versus black.

There isn't, of course, any chance of influencing change in vocabulary, but it is still fun to play with the idea. White superiority, in the Greek-based vocabulary, would become "leucodermosis," which has an appropriately diseased sound. Black Power might comparably become "melanodermosis." I know some Negroes who suffer from acute forms of melanodermosis. This is perfectly understandable, but hardly helpful in solving the problems of coexistence. It is a more reasonable disease than leucodermosis—one wonders why it has not affected everyone labeled "Negro"—but it still seems unhealthy. In its acute form it becomes "leucophobia," a hatred for all palefaces.

The Greek terms would give a new perspective on segregation. Restaurants and bars could put up signs saying "Only Leucoderms Will Be Served," which would look appropriately ridiculous. And it might be possible to work out a quarantine for real estate agents infected with melanophobia. At least such a label would seem appropriate for this particular kind of social disease.

One of the problems of racial names stems from the accident by which the aboriginal Americans came to be called Indians. This leaves

us with the awkward necessity of always using an adjective to show whether American or Indian Indians are meant. One solution has been to call the Americans "Amerinds," but this sounds to me more like a label for a variety of fruit than for a variety of people. Erythroderm doesn't help much in this case, since the need is not so much for ridicule as for a workaday word.

I was surprised to read in the article by Sol Tax in the insert on warfare in the December, 1967, issue of NATURAL HISTORY that the Indian wars of our past had great popular support. On reflection, however, this is understandable. The Indians were generally considered inferior, and we wanted their lands—so we took them. But our hatred of the Indians has subsided since we have them out of the way, nicely herded into reservations on land for which we have little use. The problems of leucoderm–erythroderm relations remain and have been dealt with in various articles in this magazine (for example, an article on the Cree in the May, 1967, issue and one on the Iroquois in the June-July, 1967, issue). We have, to a varying but large extent, undermined the values of the Indian cultures without replacing them with our own—creating a situation that looks unsatisfactory to almost everyone. Must the Indians be Westernized, absorbed into our society? Cultural diversity appeals to me as a "good thing" in itself; but not if it has to be maintained artificially on fenced reservations, dealing with vanishing cultures as we deal with vanishing wildlife.

The situation of the erythroderms in the United States is thus very different from that of the melanoderms. The Africans were torn out of their native cultures and thrust into ours. Over the generations they have acquired our values; they are Americans, which makes the caste discrimination all the more painful and senseless. James Baldwin has given a sensitive description of his personal discovery of his Americanism in *Notes of a Native Son,* and his experience is surely far from unique. Here, incidentally, we have the case of an extremely good writer who happens to have the wrong skin color.

Wrong? It is odd that a beautiful skin should be a handicap; and I, at least, find the darker human skins

more attractive than the pale ones. This must be generally true if one can judge by the amount of time pale-face people spend in trying to darken their skins. Suntan lotions, sunlamps, and beaches for sunbathing form a considerable industry. This leucoderm preoccupation with getting dark must look ridiculous to a melanoderm; it certainly makes melanophobia seem odd.

There is, of course, no such thing as a "race" in any objective sense. Some students recognize three or four races, others thirty or more; but in no case is it possible to draw sharp lines. Ashley Montagu and a few other anthropologists think it would be helpful if we abandoned the word "race" altogether and, since human differences are undeniable, wrote about "ethnic groups." I can't see that this would help much. Anyway, they have about as much chance of changing vocabulary as I have of persuading people to use "leucoderm" instead of "white." The real need in many of these cases is not so much to substitute words as it is to desensitize the words we already have.

The differences among groups of people, which we classify as racial traits, are puzzling. They include skin color, hair form and distribution, facial features, and body build, as well as differences in blood chemistry and presumably in other aspects of internal anatomy and physiology. For most of these traits I cannot see any adaptive value, although many students of the subject would disagree with me. Dark skin color, for instance, at first appears to be an adaptation to warm climates. But in the infrared parts of the spectrum involved in heat transfer, all human skin acts as a "black body," absorbing and radiating heat with equal efficiency. All efforts to show racial differences in heat toleration have failed. (Relevant studies have been summarized in an article by H. F. Blum, entitled "Does the Melanin Pigment of Human Skin Have Adaptive Value?" *Quarterly Review of Biology*, January, 1961.) Some of the proposed adaptive explanations seem to verge on the absurd: that the epicanthic fold of the Mongolian eye is a protection against the glare of snowfields; or that the same Mongolians have little facial hair because ice crystals forming in a beard would be inconvenient.

But it is difficult to explain many human features, whether they characterize particular races or the species as a whole. Desmond Morris, in a thought-provoking book published last month, *The Naked Ape*, has looked at the possible evolutionary background of many human peculiarities; his ideas, whether valid or not, should at least stimulate discussion. He reviews, for instance, the various explanations of our lack of body fur: that it makes it easier to catch lice and fleas; that primitive man was a messy feeder and could not keep fur clean; that the loss of fur was a consequence of the acquisition of fire; that the fur was lost during an aquatic stage in human evolution. He seems himself to favor the idea that the naked body would have a cooling advantage in the quick spurts of running by early hunters.

Leucoderms don't come out very well if we compare different races in biological terms. The trait of hairlessness, for instance: leucoderms have more body hair than any other human type, which would make them backward in comparison with th

more hairless melanoderms and xanthoderms. The lips form another human peculiarity, the inside lining of the mouth coming outside (Morris thinks this serves as a sexual signal). The melanoderms would win here too, with their thicker lips. In general, the melanoderms seem to be the most advanced of racial varieties—and Africa appears to be the center of human evolution—which gives no help to people suffering from leucodermosis.

But generalization of this sort is dangerous. I found a book, published last November by the distinguished biochemist Roger Williams, entitled *You Are Extraordinary*, particularly interesting in this respect. Williams is attacking the concept of the "normal" or "average" man, which could apply equally well to the average for any race. We all know that individuals look different and have distinctive fingerprints; if we stop to think, we realize that each has a different smell—as every bloodhound knows. Our insides differ greatly: stomachs come in all sorts of shapes and sizes; the heart is even more variable than the stomach; sense organs differ in acuity from person to person; and so on through all aspects of our anatomy and physiology.

We have to be careful then in generalizing about man or about different races. It isn't the race that counts, but the individual; and each individual is different. I particularly like an analogy made by Williams: "Social science built on the average man would be like United States geography built upon the concept of the 'average state': It has an area of 72.000 square miles and a population of over 3.5 million. It has about 1,200 square miles of fresh water lakes and 37 square miles of salt lake. Its highest mountains are about 6,000 feet high. About 5,000 square miles of it lie in the Arctic regions, where the ground is frozen the year round (permafrost). It has a shoreline of about 150 miles. The average state produces yearly about ½ million barrels of oil; 300,000 tons of coal; 50,000 pounds of copper; 10 million bushels of wheat; 3 million pounds of tobacco; 1 million bales of cotton; about 150,000 tons of citrus fruit and 9,000 tons of pineapples."

No one fits the average. We are not black, white, or colored. We are individuals, you and me.

Books in Review

UFO's and the Numbers Game

by J. Allen Hynek

Uninvited Visitors, by Ivan T. Sanderson. *Cowles Education Corp., $6.95; 244 pp., illus.* Flying Saucers—Here and Now!, by Frank Edwards. *Lyle Stuart, $5.95; 261 pp.*

"What's a good book on this whole UFO business?" or "Is there a really authoritative book on flying saucers where I can get the facts and judge for myself?" I am often asked these questions because of my long association with the UFO problem.

The appearance of still two more UFO books—*Uninvited Visitors*, by the naturalist Ivan Sanderson, and the posthumous *Flying Saucers—Here and Now!*, by the late Frank Edwards—provides us an opportunity not only to take a specific look at these books but to compare them with other UFO books within the framework of the above questions.

Virtually all UFO books suffer from the "numbers game." Their authors fail to see that the most important step any book could take—at least from the scientific skeptic's point of view—would be to establish beyond all reasonable doubt that just one of the reported, striking UFO cases *really* happened. That's all it would take to put the UFO problem on a scientific plane. If incontrovertible scientific evidence could be brought forth, say, that two policemen in their patrol car were truly buzzed by a fantastic craft, then science would be faced with a real challenge.

Instead, UFO authors generally try the opposite approach. Never adducing enough evidence to establish even one UFO case unequivocally, they "snow" us with case after case, one sketchy report after another, sometimes a hundred or more, under the impression that sheer numbers of improperly documented reports will establish the reality of the UFO phenomenon and gain for it scientific acceptance. We are told that at 2:00 A.M. Mrs. Jones saw a strange light out of her bathroom window, that earlier in the evening Mr. Smith saw a weird craft on his way home, and so on. The fault lies not entirely with the author. Despite twenty years of UFO study, I know of no truly puzzling UFO report that has been given the "FBI treatment" where every clue and lead is followed to the bitter end, to get at the root of the matter, as is done in the case of a kidnapping, a narcotics case, etc.

Both books reviewed here fall into this trap. Of course, a heavily footnoted, scientific document, painstakingly probing into every crack and corner to establish incontrovertibly that even one true UFO exists (by true UFO, let us define an event that happened as described but that does not fit into our present scientific and technological framework), would eventually be more important than *Origin of Species* to our philosophical outlook—but it wouldn't sell. Both *Uninvited Visitors* and *Flying Saucers—Here and Now!* are for the public and are written in a popular non-technical style. This is particularly true of the Edwards book. Edwards was a newsman, and unabashedly wrote as a newsman, with his eye on the interest-capturing story and not on its veracity. His utter disregard for documentation will be galling to the intelligent reader; still, he tells many a good story—and some of them might just be true.

Edwards frankly states at the start that he treats the subject as a news-

A barber in Ohio snapped this photo of a supposed UFO above a house.

man. "If the evidence constitutes what it seems to indicate, the presence of the UFO's amounts to one of the greatest news stories of all times and, as a professional newsman for more than forty years, I have tried to deal with it as such."

An outstanding fact about the Edwards book, however, which must be emphasized because of its implications, is that all of the many UFO stories he cites were reported in just a sixteen-month period centered about 1966. He does not go into the past to dig up the worn UFO classics, but he works exclusively with well-reported sightings of the very recent past. This much I can personally vouch for: the entire call for a scientific study of the UFO phenomenon can be based on the mass of reports from 1965-67. Had no UFO's whatever preceded this period, enough interesting reports now exist to demand serious attention.

Why has such a study not been made? The sheer incredibility of the reports, for one thing. The espousal of the UFO cause by the wishful thinkers and the lunatic fringe, for another. But most important, the fact that most reported UFO's are really IFO's (Identified Flying Objects)—misidentifications of familiar things seen under unusual circumstances. We are forced to our original point: what is needed is a UFO book—perhaps of several volumes—devoted to one case alone, establishing its reality as a true UFO rather than as a misidentification or hallucination.

One book, *Incident at Exeter*, by the newsman and writer John Fuller, has valiantly attempted this, and had the approach been made with the aid of hard-nosed scientific investigators it might have succeeded. As it stands it excites and intrigues but does not convince, at least, not the scientist.

A book directed toward the scientist is Vallee's *Challenge to Science*, but once again it has failed to pack a scientific punch. To one who wishes to become quickly informed on the global UFO problem, it nonetheless rates, along with his *Anatomy of a Phenom-*

Continued on page 66

AN IMPROBABLE SOLID

Water is one of chemistry's most nonconforming molecules. Its unorthodox behavior—it grows lighter in weight as it changes into ice—has been a monumental factor in the development of life on earth

by David Webster

If ice were heavier than liquid water, and thus sank, all of the oceans, lakes, ponds—all of the water on earth—would have frozen solid long ago. Under these circumstances, on a planet encased in ice, life would probably be impossible.

But ice floats. And the reason it floats is based on one of the most improbable facts in all of chemistry. When water begins to cool it contracts and becomes heavier, much like any other substance. It continues to act in a perfectly predictable manner until it reaches 39° F. Then a strange thing happens. It begins to expand, and by the time the freezing point (32°) is reached, it has expanded so much that it becomes lighter, only 92 per cent as heavy as an equal volume of water.

Each molecule of water contains two hydrogen atoms and one oxygen atom—the familiar H_2O. These atoms are tied together by a chemical bond. From 39° downward to the freezing point, the water molecules begin to line up and become tied to one another in a crystal lattice work that holds the hydrogen and oxygen atoms farther apart than they are in liquid water. This "airy" crystal structure gives the ice buoyancy. In other words ice expands, and so it floats. Through the techniques of physical chemistry, notably X-ray defraction, we can accurately picture the atomic structure of these ice crystals, even though we can't see it literally. That ice expands, however, is easily observed by noting the hump on the top of an ice cube. Because the water nearest the tray freezes first, it encases the unfrozen water and pushes upward in the direction of least resistance as it becomes ice.

Most people who live in northern climates have witnessed the icing up of a pond. The events leading to the freeze-up—which occurs suddenly in a day or two—take place gradually over a period of several months. These events are important to the aquatic life that must spend its winter sealed under the ice. By late summer the pond reaches its maximum water temperature, and then, as the days shorten and the chill of autumn arrives, the pond begins to cool. When this happens the water at the top of the pond cools first, contracts, and becomes heavier. The heavy water sinks to the bottom, pushing warmer, lighter water to the top. This natural circulation is known as "pond turnover." Some of the oxygen on which aquatic animals depend during the winter comes from air that is dissolved in the water as it circulates; so, the longer pond turnover continues, the greater the winter oxygen supply will be. Pond turnover continues until the water reaches a uniform temperature of 39°, then as the water expands, turnover halts.

In the first stages of freezing, the pond becomes edged with a

Leaves on the bottom of a pond, ab·ve, are clearly visible through the tra· ·parent ice that forms as a thin layer across the surface in the first stages of freezing. At left, the stems of emergent water plants protrude through clear ice, then arch back into the icy crust. In spring, as temperatures mount, large cracks appear in the white ice, below. Its color is caused by trapped gases.

Moving water ordinarily remains free of ice much longer than does standing water. Even though the surface of the stream, above, has not frozen, a fringe of ice has developed around a rock because the barrier broke the stream's momentum and froze the resulting spray. Ice on the windward side of the twig, below, was piled up by an ice storm. The icicles projecting downward from the twig were melted where they made contact with the moving water.

paper-thin ring of ice. Even though the air temperature may be colder than that of the soil and rocks, water is cooled much more quickly by contact with denser materials. Soon the entire surface of the pond is covered with a layer of thin clear ice. This gradually thickens and appears black, because it allows one to view the dark water below through the ice layer.

As long as the weather remains cold, the thickness of ice increases, but at a diminishing rate. If the air temperature reaches 10° during the night, the temperature of the ice gradually becomes equally as cold, causing more water to freeze along its undersurface. As the air warms up during the day, the ice acquires a uniform temperature of 32°. Soon the thick ice so effectively insulates the unfrozen water from the cold air above that very little additional ice is formed.

After a few weeks black ice usually becomes white ice. The milky color is caused by gas bubbles that are trapped underneath. This trapped gas is a by-product of decay and photosynthesis, because as long as the icy surface of the pond remains free of snow, sunlight and heat can pass through it. Thus, the normal life of the pond continues, sealed away from winter temperatures. If, however, the pond becomes covered with snow, sunlight is blocked and photosynthesis stops. If this situation continues for any length of time, winterkill occurs, usually destroying most of the life in the pond. Larger bodies of water take much longer to freeze completely. Deeper water remains free of ice long after shallow ponds have frozen over.

Salt water freezes at a temperature of about 29°. Great expanses of the Arctic Ocean freeze each winter. Indeed, several of the carnivorous mammals of the northlands expand their ranges by hundreds of miles during the winter months. Polar bears and Arctic foxes, for example, may spend much of the winter far out on the frozen ocean surface feeding on fish and seals, as well as marine animals that they dig out of overturned ice.

Being frozen in ice is not necessarily fatal to organisms. Many shallow tundra lakes and bogs freeze to the bottom each year, and some may remain frozen for a period of several years. Nonetheless, there are some hardy animals, such as protozoans and rotifers, that are able to withstand these conditions. Even ponds where winterkill has occurred and solid freezing has taken place support a teeming population of bacteria and other decay organisms—as anyone who has ever been near a reeking winter-killed pond in spring will attest. Some larger animals such as goldfish survive freezing in garden ponds, which suggests that this could happen to fish in natural bodies of water.

The thawing of ice takes place as rapidly as does its formation, often accompanied by loud cracking and booming, depending on the size of the body of water. Much of the melting occurs on the undersurface of the ice, since the heat of the sun is conducted through the ice to the pond water and heats it a few degrees above the freezing point. Even if the air above the ice is many degrees warmer this is still the case. The same principle holds for an ice cube; in water it melts much more rapidly than in air at the same temperature or even warmer, because heat is conducted to the ice more rapidly by water than by air. Initially, the ice disappears from the places where it formed first. Large cracks appear and the entire surface begins to break up. Within a week's time the pond is again ice free. Perhaps this event was best described by Henry David Thoreau: "I looked out the window, and lo! where yesterday was cold gray ice there lay the transparent pond already calm and full of hope as in a summer evening, reflecting a summer evening sky in its bosom, though none was visible overhead, as if it had intelligence with some remote horizon."

Across Earth's Crucial Boundary

In this microclimate zone, extending from about six feet above to several feet below the ground, energy from the sun becomes heat that supports life and helps determine the world's weather

by Thomas M. Griffiths

Research data helped move wheat northward in Alberta. Death Valley (below) typifies another microclimate.

Horizontal trees (Krummholz) *on ridge in Colorado's Rockies dramatically show what strong prevailing westerly winds did to timberline growth.*

At any given hour of the day or night, winter or summer, omewhere on our earth close to he surface of the ground, scientific nstruments are recording tempera- ures, radiation, humidity, wind elocity, wind direction, and atmo- pheric pressure.

A set of unattended recording in- truments may be making the meas- rements far north, at the edges or enter of the Greenland icecap. A cientist may be extracting data from n instrument installation far south, t some remote station in Antarctica. The site may be flatland, such as coastal tundra near Point Barrow, laska, or stunted Arctic forest near Yakutsk, Siberia. But the location may also be beyond timberline in the Rockies, such as the University of Colorado's Station D-1, where a set of microclimate recording instruments stands on Niwot Ridge in an alpine world of rock, snow, and tundra, 12,300 feet above sea level. To reach this site university researchers must depend upon the crawler vehicle called a weasel.

But measurements are not limited to isolated or hazardous places. The site may be an Austrian or German vineyard, a peat bog in Wisconsin, an experimental forest in Oregon, a trial cotton plot in Australia. Significant readings may also come from the street pavement or the sides of a building on Main Street, U.S.A.

All these investigations have one thing in common: to collect data about the world's microclimates. The work is therefore limited to the earth-air boundary zone, which normally extends from less than six feet above ground to a depth of several feet into the soil. There are good reasons for studying this relatively thin, but crucial, slice of the environment. It is especially interesting to the plant ecologist, for instance, because a high percentage of the world's natural vegetation grows on, and close to, the earth's surface; and so do a major portion of the world's food crops. Moreover, the five- to six-foot layer of air just above the earth's surface is the natural environment for most of mankind.

This zone has another distinction. Just as nature is said to abhor a vacuum, nature abhors a boundary. This axiom often confronts the geographer. For example, if he tries to define the northern timberline by a sharp line on the ground, he finds that he can scarcely do so because nature has blurred the terrain with a transition zone—in some cases rather wide—between timber country to the south of the zone and tundra to the north. Even such well-defined boundaries as shorelines or stream banks are ephemeral at best. They are constantly being changed by the forces of erosion.

Yet there is at least one natural boundary that seems well defined and has an importance out of all proportion to its simplicity. This is the surface of the earth, the well-defined boundary plane where lithosphere and hydrosphere—the rock and water portions of the earth—meet the atmosphere. Only in relatively recent times have investigators focused attention on this boundary; agronomists began to do so just over 50 years ago.

The usual plant grows with its roots embedded in the earth and the remainder in the atmosphere. In this way it partakes of the environment on both sides of the boundary. An early finding by the investigators was that plants are particularly sensitive to short-term changes that occur in either the air above or the soil below the surface boundary.

At about the same time that agronomists were recognizing the environmental importance of this zone, meteorologists began taking a serious

look at it. They were interested because solar radiation here undergoes a highly important change into heat; it arrives from the sun as short wavelengths of light, but cannot heat the atmosphere directly until it is converted to long wavelength energy.

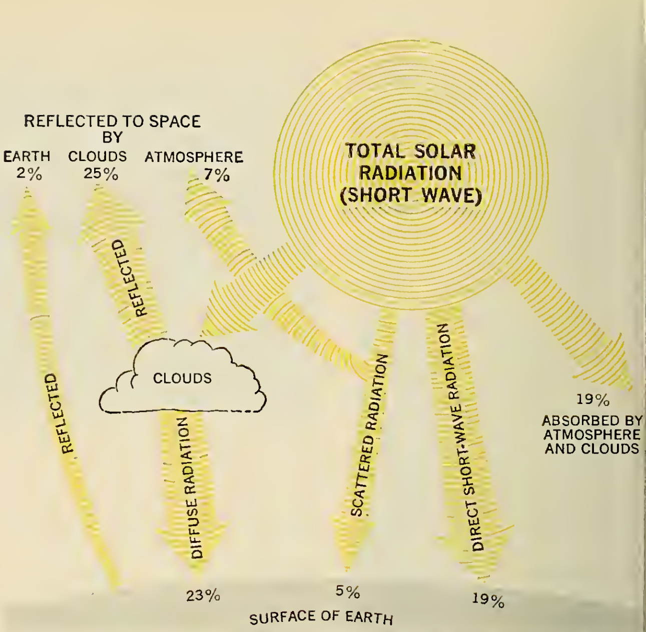
Not all of the incoming solar energy gets this far. An estimated 34 per cent is scattered back to space in its initial short-wave form by small particles in the air, reflection from cloud tops, or reflection from the surface of the earth. This unconverted portion heats neither the earth nor its atmosphere. Of the remainder approximately 19 per cent heats the atmosphere directly by being absorbed and converted directly into long-wave radiant energy, principally by water vapor. This leaves 47 per cent that reaches the earth's surface either as direct sunlight (19 per cent) or as scattered and diffuse daylight (28 per cent).

Here the major conversion takes place. The short-wave light is absorbed and then reradiated as longer waves of radiant energy, equivalent to what we call heat. Some of the heat is transferred by ordinary conduction into the ground—one result is thawing of the ground in the spring. The rest goes upward: it is transferred to layers of air near the earth's surface, and sets convection currents in motion. These then carry and mix the lowest, heated layers of air throughout the restless atmosphere, which works like a vast heat engine to produce the world's weather and climates.

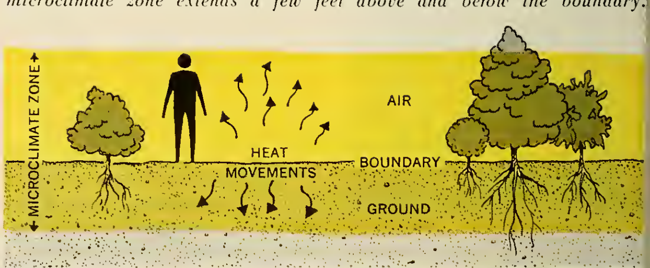
At first glance the worldwide energy-transfer mechanism appears rather straightforward and simple. In practice it is unbelievably complex. For example, solar energy reaches the top of the atmosphere at an almost constant rate known as the *solar constant*. In an average 12-hour period this radiation totals almost 1,400 gram-calories per square centimeter. But the energy must then find its way past a number of traps and diversions —such as dust and smog as well as water vapor—before it can hope to reach the earth's surface.

Once at the surface, the energy meets a mixed reception. If it falls on dark-colored rocks, a high percentage may be converted to heat and transferred to the lower layers of the atmosphere; if it falls on a snow-covered surface, most may be reflected back into the atmosphere and do very little to heat that region. When these and other factors are taken into account, the task of determining the energy balance of the atmosphere becomes so staggering that several types of scientists focus their attention on separate parts of the process. Among these people the micrometeorologist focuses on the earth-air boundary and the energy transfer taking place there. And if he is concerned with long-range averages and characteristics, he calls himself a microclimatologist ("micro" because his data are from a relatively thin segment of the atmosphere).

Basically, he focuses on the energy exchange process constantly taking place across the earth-atmosphere boundary. But this exchange is controlled by such a multitude of effects that each small part of the earth's surface has its own unique microenvironment, so to speak. Furthermore man has so altered the face of the earth that many of the effects normally occurring in a state of nature are absent in the altered landscape. Consequently, the investigator must



Above: almost half of solar radiation reaching our atmosphere passes on to earth's surface and is converted to heat. Below: the heat penetrates ground by conduction, and also radiates upward. Man's height shows that crucial microclimate zone extends a few feet above and below the boundary.



:onstantly revise his answers and his echniques for gathering data.

For example, more than 20 years ıgo climatologists began to realize hat large urban centers had higher ımbient air temperatures. both day ınd night, than the surrounding :ountryside. Since this discovery, nasses of data have been collected. The most striking impression of the ıltered city climate can be gotten 'rom a high-flying plane approaching ı city on a clear day. A dark-gray. ;lowly rising "mushroom" of smoke and pollutants is piled up over the urban center, vastly altering the city's entire radiation balance. Frequently, there are also the special cases when a winter temperature inversion traps the city's pall of dirt and pollution under a lid of imported warmer air. In general, man seems bent upon covering the entire surface of the earth with brick, concrete, and asphalt. When this is accomplished, the energy-transfer characteristics of the surface will be vastly altered, mostly for the worse.


Colorado researchers read the wind record at about man's height.

Another branch of microclimate research deals with soil temperatures. For instance, permafrost has claimed considerable attention. A significant part of the land surface of North America and Eurasia is underlain by permanently frozen ground. confronting development programs with severe problems in such fields as transportation networks, urban construction, plant husbandry, mining. and, in fact. all surface and subsurface activities. Accordingly, microclimatologists have supplied and still supply a great deal of the basic data needed for coping with permafrost conditions.

Sometimes the investigations bring unexpected findings. For instance, a close study of the temperature regime near the earth's surface in permafrost regions has uncovered a phenomenon called thermal erosion. Small streams on Arctic coastal plains extend their courses headward and deepen their channels not so much by transporting sediment that they have already eroded by normal means as by melting their way into the permafrost.

Outside of permafrost regions, too, the temperature of the soil affects many of man's interests. This temperature is in part a measure of the rate at which incoming radiation is absorbed or given back to the lower atmosphere. The rate has a vital effect upon growing plants; it may indicate the rate or likelihood of frost occurrence, and it is associated with air movements caused by temperature changes close to the surface. As an example, the citrus grower during critical periods in the spring needs to know soil and surface air temperature precisely before he can combat frost danger. There are similar implications for industrial designers. Where to locate a smelter that will be spewing forth noxious fumes should be based on a knowledge of both local and prevailing wind movements at the earth's surface. (Wind is air moving from high-pressure (cold air) areas to low-pressure (warm air) areas.)


Like photo above, this one was taken 12,300 feet above sea level in the Rockies. Soil-temperature box has maximum-minimum thermometers.

There is also the broad significance of cold temperatures. About 10 per cent of the earth's land surface is covered by icecaps and glaciers. These ice masses lock up so much of the world's total water supply that, if they suddenly melted, the level of the seas would rise several hundred feet. To understand the cyclical climatic conditions that induced the onset of glaciation about a million years ago, and also the climatic trends of today, glaciologists turn frequently to the methods of the microclimatologists, among others. With thermistors, instruments whose electrical resistance varies with temperature, they measure the penetration of the annual heat wave into the ice during periods of high sun. Other measurements determine the reflective properties of snow cover and the rate of energy transfer at the glacial surface. Net radiation is measured, as are wind velocities and air-mixing ratios close to the surface. Rates of accumulation and ablation are determined, providing a measure of the

glacier's moisture and heat budget.

A few years ago, scientists of the Cold Regions Research and Engineering Laboratories, Hanover, New Hampshire, made a detailed microclimate study of ice and air temperatures in the walls and within the cavities of several large crevasses near the edge of the Greenland icecap. These crevasses, covered with fragile snowbridges, were a menace to over-snow travel, and could not readily be detected by aerial photographs. The investigation revealed that a heat flux existed over the center of the crevasses. During the summer months heat moved from the snowbridges into the open space of the crevasses, then downward and outward into the ice. Using this information, other scientists were able to develop a method of detecting hidden crevasses based on airborne, infrared heat-sensing equipment.

In the field of plant husbandry, the microclimatologist has made some of his most important, practical contributions. Wine growing, citrus fruit culture, forest management, truck gardening—these have benefited from his describing the environment quantitatively, thereby helping the plant breeder to develop the type of plant suitable for a given environment. The northward march of wheat in western Canada is a classic example of cooperation between microclimatologist and plant breeder.

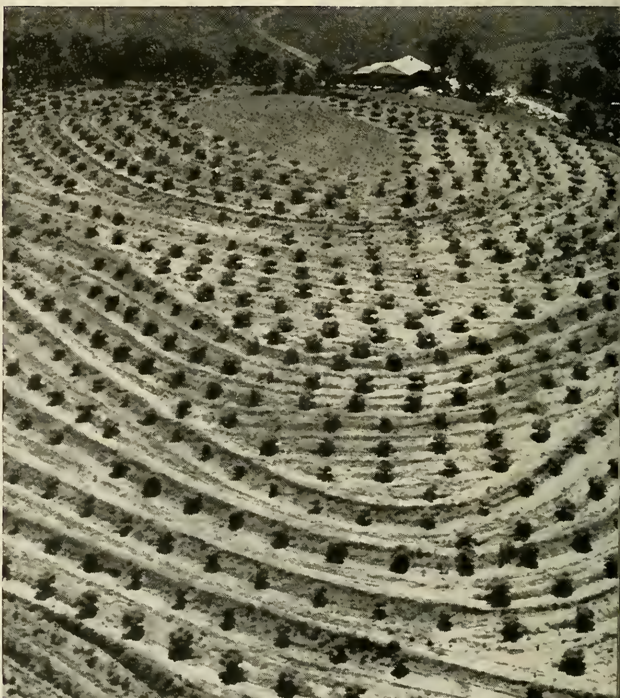
At each pioneer location, as attempts were being made to push farther and farther north in the high plains, the climatologist measured soil temperature and frost-free period. Based on these measurements, the plant breeders at such locations as the Agricultural Experiment Stations at Beaverlodge and Fort Vermillion, Alberta, have been able to select and develop strains of wheat that will mature in the shorter growing season and rigorous soil temperatures. Alberta's provincial government has based its settlement policy upon these developments. It doesn't permit agricultural homesteading where the climate is too severe or the soil unsuitable for the plants.

Although not aimed at quick, practical results, the research into microclimates of the boundary zones has been as dramatic in the field of plant ecology. A generation ago most school atlases contained a sketch depicting a number of the Western Hemisphere's high mountains arranged by latitude, because latitude was assumed to be the primary control of climate. From these idealized sketches, classroom teachers developed a rule of thumb: "In terms of climate, a mile of latitude is equal to one foot of altitude." That is, one can change climate by gaining elevation at the same latitude or by traveling north without gaining altitude.

Also, it was assumed that other ecological aspects dependent on climate—such as timberline or the range and composition of certain plant communities—were subject to the same rule of thumb. Thus, if timberline was at 11,000 feet above sea level on Pikes Peak, it should be at 10.000 feet above in the Canadian Rockies, 1,000 miles farther north. That this rule of thumb was very inaccurate seldom bothered its users.

The situation has change
Thoughout the world many resear
stations have been providing mo
reliable data and guidelines. On t
sea-level tundra near Point Barro
Alaska, microclimatic data have be
gathered for a number of years.
the Agricultural Experiment Stati
at Katherine in northern Austral
microclimatic information has aid
the development of new crops. A r
sonably lengthy record has been o
tained at Byrd Station, the Sou
Pole, and at the Russian Mirny S
tion in Antarctica. Humidity, temp
ature, wind, and soil-moisture inf
mation is being gathered under t
high rain forest canopy near Kua
Lumpur, Malaysia. Graduate s
dents make regular observations
air-temperature profiles across W
cester, Massachusetts; St. Louis, L
Angeles, and Munich.

Another example is the work do
by the University of Colorado's
stitute of Arctic and Alpine Resear



Two examples of modifying earth's surface: contour farming combats erosion by planting rows in a way that reduces water runoff; Kennedy Airport, right, altered its microclimate with artificial ground cover.

he early 1950's, directed by Dr. n W. Marr, it began a continu- series of investigations into the tionships between altitudes, cli- e, and plant communities, in ns of ecosystems. This line of re- rch soon showed a primary need a set of microclimate stations in Front Range, west of Boulder, orado. The stations were located hin the altitude range provided by h of four climax environments— re a state of equilibrium has been undisturbed and has gone ough a succession of plant species il it consists of those most success- under the physical conditions of nate, relief, and soil. These climax ironments are: the Lower Mon- e Forest Climax Region (6,000- 00 feet); the Upper Montane est Climax Region (8,000-9.000 t); the Subalpine Forest Climax gion (9,300-11,000 feet); and Alpine Tundra Climax Region ,400 feet to mountaintops). The university already had its Science Lodge, 9,600 feet up a slope of Niwot Ridge. This center, now the Institute's home site, also serves as field base for the four-station network.

Since 1953 a continuous record of microclimatic information has been collected at the stations. The lower ones were relatively easy to establish and maintain. Understandably, the alpine station, at 12,300 feet on an eastward-extending spur from the crest of the Front Range, has given more difficulties. Here, although air temperatures drop as low as —34° Fahrenheit and wind velocities reach as high as 50 miles per hour, a maintenance crew comes by weasel each week to service the instruments, read data, and collect the charts produced by instruments since the previous week's visit. All air-temperature, pressure, and humidity instruments are in special shelters 40 inches above the ground. Here in bad weather the men work in relays, dashing outside their emergency shelter cabin into the wind to change hygrothermograph charts, read air and soil thermometers, record anemometer totals, measure the accumulated moisture, and so on.

As their microclimate record has lengthened, the Institute ecologists have gained a surer grasp of the atmospheric and soil temperature factors that play a vital role in the differentiation between tree and tundra zones, not only at this middle-latitude station but also in tropical and Arctic latitudes.

Thus through patience, sometimes with peril, and always by drudgery, the world's microclimatologists go on gathering measurements that describe the environment at the boundary between earth and atmosphere. Nature may abhor a boundary, but here is one boundary that is at last beginning to receive the amount of attention it needs.

SKY REPORTER

British astronomers, undeterred by the cloudy skies and high latitude that make their island considerably less than an ideal location for those who look heavenward, are happily testing the new 98-inch Isaac Newton Telescope at the Royal Observatory at Herstmonceux.

Queen Elizabeth dedicated the new instrument in December, twenty-two years after it was first approved by the government and many years after it was first proposed. Testing is expected to be completed by the fall of 1968, when the first researchers, approved by a special panel, will begin using the telescope.

Sir Richard Woolley, Astronomer Royal, indicated that one of its first uses would be locating sources of radio emissions. Commenting on the problem of cloud cover, he said: "It is likely that some work can be undertaken on at least 40 per cent of the nights of the year."

Observers will be expected to maintain a constant watch for breaks in the weather, he added. Long-exposure photographs might be attempted on 20 per cent of the nights.

Weather has played an important part in causing British astronomy in the past to lean toward the theoretical side. The Science Research Council hopes the Isaac Newton Telescope will result in a better balance between theory and observation.

There's more to come. An Anglo-Australian team is planning a 150-inch telescope to go into operation in New South Wales about 1975. In the field of radio astronomy, where the British have distinguished themselves for years, plans are being drawn up for a 400-foot, fully steerable radio telescope. It would be used in tandem with the 250-foot instrument at Jodrell Bank, now the world's largest fully steerable dish, to give radio astronomers better resolution.

Final government approval is expected in time to have the 400-foot instrument in operation by 1971.

COMET HUNTERS' RECORD YEAR

The year 1967 was the best ever for comet hunters, who discovered new ones or found old ones at a rate of better than one a month.

The fourteenth and last, Comet Ikeya-Seki, was a ninth magnitude object visible before sunrise in January as it moved slowly northward through the constellation Ophiuchus. The comet's name should sound familiar; it was named for the same two Japanese astronomers who discovered the spectacular sun-grazer of 1965, which could be seen during the day as it swung around the sun.

For Tsutomo Seki, the last comet of 1967 was the fifth he has discovered since 1961. There is no secret, he says. "All you have to do is to be very patient. You should be very persevering and should not rely on bits of good luck."

Owen S. Gingerich, who headed the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts, until the end of 1967, says it takes about 100 hours of sweeping the skies to find a new comet. Other estimates range up to 300 hours.

VARIABLE STARS

Robert F. Garrison and Armin Deutsch of the Mount Wilson and Palomar Observatories needed a light curve of Mira, the famed long-period variable star in Cetus, extending back over decades. They wanted to try to correlate peculiar changes in the spectrum with variations in the light curve from one cycle to the next.

S. H. Plagemann of Cambridge University in England wanted curves for 10 T Tauri irregular variables.

Hugh Johnson at Lockheed Aircraft's Palo Alto laboratory wanted observations of the X-ray source Sco X-1 while he made observations at Kitt Peak in Arizona.

All turned to the Cambridge, Massachusetts, office of the American Association of Variable Star Observers, a worldwide group of amateurs directed by Mrs. Margaret W. Mayall. Using special AAVSO charts to help them accurately estimate magnitudes, observers keep track of the light fluctuations of nearly 1,000 stars.

In her annual report, Mrs. Mayall lists the work of 350 observers—some 129,642 magnitude estimates. Each is recorded on a punched card and on magnetic tape, and the observations are correlated to give a nearly continuous curve showing how a variable's brightness changes with time.

Valuable information is provided for the professional community by accurately timing the minimum light of one class of variable stars known as eclipsing binaries. When a close binary system is lined up edgewise with the earth, it appears to an observer as a single star whose magnitude periodically and suddenly drops for a short time. This occurs when one of the stars in the system passes in front of and eclipses the other. Professional astronomers are interested in determining the period of these binaries and even more interested in whether the period changes. These could indicate mass changes or reveal a third star in the system.

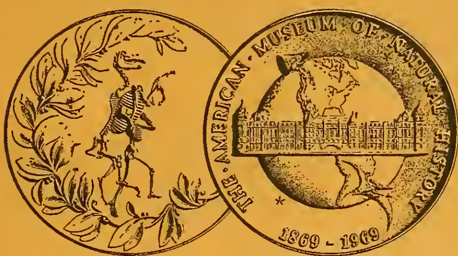
Twenty-eight observatories receive AAVSO's quarterly reports and annual predictions on variable stars.

Amateurs in the program know they are providing useful information. They also receive public credit; lists of observers and the number of estimates they have submitted to Cambridge are published six times a year in the *Journal of the Royal Astronomical Society of Canada* and in the *Review of Popular Astronomy*.

The record is held by Robert Monske, a high school student in Mercer, Pennsylvania. In 1966, he submitted 11,407 observations. A milestone was reached last July 15 when Carolyn Hurless of Lima, Ohio, recorded the magnitude of RS Ophiuchi as 10.8. It was the 2,500,000th observation made by the AAVSO.

John P. Wiley, Jr.

OUR 100TH YEAR



THE AMERICAN MUSEUM OF NATURAL HISTORY
CENTRAL PARK WEST AT 79TH STREET
NEW YORK, N. Y. 10024

OFFICE OF THE PRESIDENT

Dear Museum Member:

On April 7, 1968, The American Museum of Natural History begins its one hundredth year. To celebrate the centennial we are preparing events of major importance which we hope you will share with us.

Notable among them will be a series of six one-hour nationwide television broadcasts bringing the Museum to the homes of millions.

Other highlights will be the opening of five new exhibit halls, each a masterly synthesis of science, technology, and artistry. For example, the Hall of Ocean Life, our largest exhibit, has as its focal point a superb 94 foot model of a blue whale poised in the act of breaching.

You, especially, can appreciate the value of the Museum's contribution to humanity as a living center of research and education. All these activities are financed in large part by the gifts of individuals and we greatly appreciate your active support through membership.

At this exciting time, we in the Museum are expending extra energy and initiative to cap the century successfully. I ask you, too, to make an extra contribution towards the success of our 100th year and continued greatness in the future.

Thank you for your generous response.

Sincerely yours,

Alexander M. White

Alexander M. White

P.S. A reply envelope is attached for your convenience.

THE AMERICAN MUSEUM OF NATURAL HISTORY ANNUAL REPORT TO MEMBERS 1967

THE PRESIDENT'S MESSAGE

As I write this year's message, I am happily aware that this venerable institution has succeeded in maintaining a youthful vitality remarkable for a 99-year-old. The Museum, like some living systems in nature, has followed a pattern of growth and self-renewal. The growth has not been a random one, however, and the renewal has not been automatic. They have been part of a plan carved out by hundreds of men and women of the Museum who, as well as being proud of their past achievements, are constantly seeking new ideas, new techniques, and new knowledge. This is the spirit that one finds in the Museum one year before its 100th birthday, and this is the spirit that will guide it through another century of growth.

Education, of course, is the prerequisite of mental growth. As Thomas Huxley put it more than a century ago: "To a person uninstructed in natural history, his country or seaside stroll is a walk through a gallery filled with wonderful works of art, nine-tenths of which have their faces turned to the wall."

The most visible aspect of the Museum's many-faceted role as an educator of natural history is our exhibition program. Today, every floor is buzzing with activity. Scientists, artists, artisans, carpenters, plasterers, electricians, yes, even cost accountants, are working together as a team in the process of updating, restoring and rebuilding halls and exhibits. Work is proceeding rapidly on six new halls, and their opening will signal the arrival of the Centennial Year of the Museum. In this process of renewal the old blends with the new and our Museum takes on a new look. This new look, I am happy to report, is being noticed today and commented upon by our visitors.

Exhibition may be the most visible aspect of our role as educator, but other facets of our program play an equally meaningful role. One of these is the Department of Education itself, which conducts literally scores of programs covering an age range from youth to senior citizen, and an educational span from grammar to post-graduate school.

Indeed, the Department's projects reach out beyond the walls of the Museum to include a wide variety of people who find it impossible to come here. These programs, like those conducted inside the Museum, are motivated by the desire to illuminate the mind, to kindle the fires of curiosity about man and his environment.

Perhaps the most formidable challenge in the years ahead—for both the nation and the world—is the task of advancing and disseminating man's knowledge. Economists tell us that today the largest enterprise in the United States is the "knowledge industry," which includes schools, colleges, universities, museums, publishing houses, and numerous other fields. The Museum is proud to be actively engaged in this most creative of all enterprises. We will always have a distance to go, but I believe that our Museum is on its way toward meeting this challenge.

Alexander M. White

Alexander M. White
President

Among the most awe-inspiring exhibits at the Museum are the re-creations of dinosaur skeletons. Above, a teacher answers youngsters' animated questions.

THE DIRECTOR'S MESSAGE

Answers to the recurrent question "What is man?" vary from a flippant retort to a philosophical essay or a series of scientific observations. Man's intricate and complex behavior has no doubt fascinated and plagued his fellow man since the beginning of self-consciousness.

The very complexity of man which makes him perhaps the most fascinating and certainly the most dangerous form of life on this planet also makes any single answer incomplete and unsatisfactory. The question has engaged the thoughts of both ancient psalmists and modern statisticians, and the search for answers will continue as long as man exists.

Many biologists have pointed out that man differs from other mammals in a *quantitative* way only; he differs, as Raymond Pearl says, "by virtue of being only *more* so rather than by being completely alien in kind." This quantitative difference, however, involves the many attributes, developments, and characteristics that put man in a unique class. It is this difference that has enabled man to achieve the most diverse and adaptable behavior in the world—behavior that has produced a written record of symbols to transfer knowledge from generation to generation and from place to place and that has enabled him to modify his environment to an astounding degree and to develop the technology that will soon enable him to move from planet to planet before, it is to be hoped, he completes the destructive remodeling of the planet earth.

To help solve the dilemmas of our times—to help people achieve a better understanding of the world in which they live—is a task that poses a double challenge to the scientist. At the same time it offers him a double opportunity, for the problem requires a two-pronged approach: basic research combined with education. Research is necessarily the forerunner of education and Museum scientists are conducting original research on many different problems. The primary purpose and obligation of the Museum is to provide education for members of the general public according to their interests, and for students, teachers, and scientists according to their needs.

Teaching, in the traditional role of personal guidance and face to face communication, is the special province of the Education Department. But the full scope of education at the Museum is not limited to any one department or division. Each department makes a distinct and needed contribution to our educational goals. When a curator plans an exhibit, he is planning for public education. When architects, artists, and preparators design and execute a display to convey the curator's message, they engage in an educational function. Through his research the curator continually educates himself in order to better educate others. And all these efforts are combined to improve the knowledge and understanding the Museum may offer to the public.

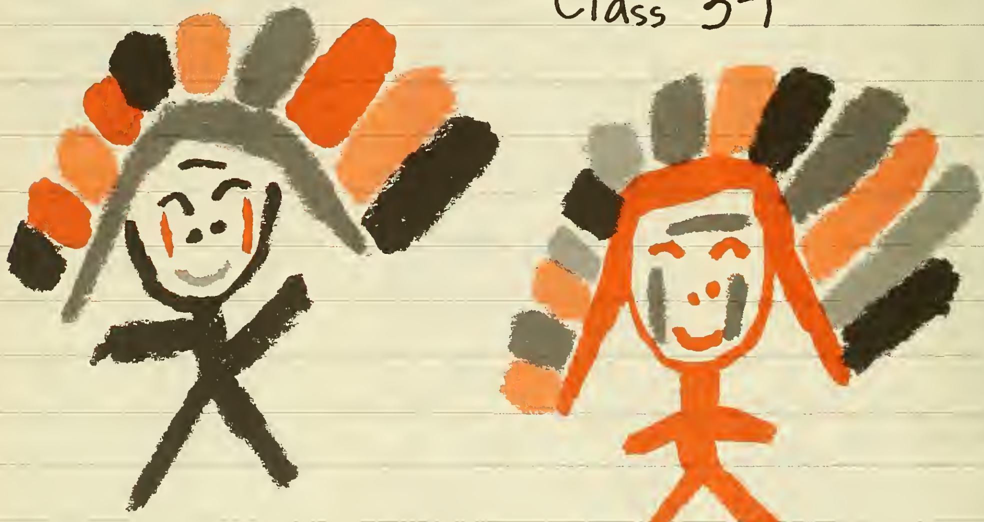
James A. Oliver

James A. Oliver
Director

P.S. 152. Q.
Woodside N.Y.
Dec. 5. 1967

Dear Mrs. Mills,
Thank you for the guided tour.
It was a wonderful experience learning about the Eastern Woodland Indians.
We enjoyed seeing how the Indians pounded the mortar pestle.

Your Friend
Class 3-1



"If a museum were to be restricted to a single goal, that goal should be to pass on as completely as possible the knowledge accumulated."

Dr. James A. Oliver
Director

A visitor's first step into The American Museum of Natural History is a step into a world populated by relics of millions of years of the earth's development, by fossils, fragments, dioramas, displays, by works of art, works of nature, and the work of men and women who, for the past 98 years, have made the Museum tick. It is a fascinating step to take, but often a bewildering one, as the visitor can easily become lost in the sheer magnitude of the institution.

Many visitors come to see particular exhibits, others to wander through the Museum, sampling its offerings, discovering for themselves its many treasures. Still others seek help. Frequently the help they seek is of a specialized nature ... the oldster seeking new outlets for his leisure time, the child seeking advice about the care of his pet toad, the student seeking the guidance of the scientist, the teacher seeking help in interpreting particular exhibits for his class's special needs.

Many of these visitors who seek help find it through the programs, courses, and services offered by the Museum's Department of Education. From the day the Museum first opened its doors to the public it has found a waiting audience eager not only to view the exhibits, and the first and still basic educational service of the Museum, but eager also for further knowledge, eager to receive instruction.

Over the years, in response to this desire, the Museum has developed an extensive education complex, which today serves everyone from preschoolers to senior citizens, from postgraduate students to underprivileged youngsters, and which carries the Museum's vast resources beyond its walls by means of portable exhibits, publications, and special programs.

The Department of Education, established in 1884, is one part of this complex, which, for nearly a century, has helped the Museum fulfill the promise of its founders when they wrote in the original charter that a large part of all resources would go toward the spreading of knowledge.

In the beginning the Department relied heavily on the scientific and administrative staffs of the Museum to present its courses, lectures, gallery talks, and other programs, but as both the programs and audiences grew in numbers, the Department acquired a larger and larger staff of its own. Today it is the largest department of its kind in any museum. The teachers, technicians, clerical workers, and administrative staff are direct links between the Museum and hundreds of thousands of people every year.

Over the last decade the Department, working with various educational institutions, city and state agencies, and others, has broadened the scope and variety of programs and services. Some of these are short-term offerings directed to a limited audience, but many, such as the programs for school children, are permanent, but continually evolving, undertakings that reach many thousands yearly.

Dr. Wesley E. Lanyon, Ornithology Curator, operates a radar unit at left while student releases bird. The men are testing flight speed of the bird at Kalbfleisch Field Research Station, Long Island. Photo below shows items used by the Museum for portable exhibits including films, slides, photos and sculpture pieces. The kits are sent free to schools and other institutions. On the following page, young people (left) crowd around Indian War Canoe at 77th Street Foyer. An African dancer (center) performs before a crowd at one of the Museum's Evening Adult Courses. At right, youthful visitor learns about turtles "from the horse's mouth" at the Natural Science Center for Young People.

PROGRAMS FOR SCHOOL GROUPS

The most heavily attended program for school groups is "The World We Live In," often termed the Department's "bread and butter" program. Last year it attracted hundreds of teachers who came with classes numbering more than 33,000 children, in grades 3 through 9, for a carefully organized one-day session correlated to their schoolwork. It is up to the schoolteacher to choose, in advance of the visit, one of the 20 topics currently offered.

Once here, a member of the Department's teaching staff takes over, selecting exhibits pertinent to the topic and geared to the individual class. Subjects especially popular with the schools are "Prehistoric Life," "The Physical Evolution of Man," "The Biology of Man," "Geographical Concepts," "Animal Changes Through the Seasons," "A Comparison of Primitive Cultures," and those on the Eskimo and the American Indians.

Supplementing the teaching done in the exhibition halls is a classroom or auditorium period during which films, slides, and recordings may be used, and where the class may see at close range, and sometimes handle, specimens from the Department's teaching collections, adding yet another dimension to their learning experience.

Many of the groups of young people seen in the halls during late mornings and early afternoons are taking part in this program. At present a maximum of 18 classes a day can be accepted for "The World We Live In."

Many New York City youngsters otherwise eligible for this program are unable to take part in it because they are hospitalized or institutionalized. A grant from the Avalon Foundation has enabled the Department to carry a program of instruction to these classes. This past year 7,400 children were reached by the Hospital and Special Schools Program.

Another 9,000 children attended "Exploring The Natural World," presented in the auditorium school day mornings. This hour-long program offers school teachers an opportunity to select one of four topics, each given on a different day of the week,



ach serving as a dramatic introduc-
on to a Museum visit.

Of all the programs presented by ne Education Department, this one s most like the first, also a lecture rogram, offered school classes at ne Museum in 1904. Lectures for chool classes, one of the principal ctivities of the Department for near- forty years, were dropped in the arly 40's in favor of a more compre- ensive "all-day" program, the fore- unner of "The World We Live In."

Today we are pleased to be able o offer both types of program, en- bling us to better meet the demands f the schools, and to accommodate greater number of classes. When ne rehabilitation of Education Hall s completed, we will have the space o expand "Exploring The Natural Vorld," offering additional lectures or interested school groups.

The Natural Science Center for 'oung People, located on the 2nd oor of the Museum, is extremely opular with young New Yorkers on oth solo and group visits. As many s three classes a morning visit the Center by appointment, for an hour's instruction based on exhibits devoted to the geology and plant and animal life of New York City.

No youngster, of any age, whether with a preschool class or one of the upper grades, fails to enjoy a visit to the Center with its small, native wild animals, its marine and fresh-water tanks, its rocks and minerals, and its scores of constantly changing seasonal exhibits. Supported in part by special funds, the Science Center is host not only to New York City school groups but to groups from outside the city as well. This past year 4,500 children in class groups visited the Center, one-eighth of the total attendance for the year.

A relatively new and highly successful program for high school seniors throughout the state has been organized jointly by the New York State Department of Education, Lincoln Center, and several of New York City's museums under the sponsorship of the New York State Council on the Arts. Each week a different group of 120 students arrives in the city for a program of cultural enrichment that involves contact with art, the natural sciences, and the performing arts.

While here the students are given a brief introduction to the Museum's many roles, then are taken by members of the Department's teaching staff through a number of exhibition halls selected in advance by the students. During the course of the hall lectures, emphasis is placed on the significance of man's relationships to the natural world.

Last year 1,800 students, some from as far as Buffalo and Watertown, participated in this pilot program.

Altogether, 55,700 young people took part in the above programs during the last fiscal year. Thousands of others came in contact with the Museum through the exhibits circulated by the Education Department to schools in the city. Other thousands visited the Natural Science Center on their own, or attended the Saturday film programs arranged by the Department. Others rented recorded tours or purchased Museum Trail booklets to help guide them around the Museum.

PROGRAMS FOR TEACHERS AND OTHER ADULTS

The Department's efforts are not limited to young people alone. Every year thousands of adults enrich their lives and broaden their outlooks through gallery talks, slide talks, film programs, lecture series, teachers' courses, field walks, and other programs.

Before the Museum had been open a year, large numbers of school children and their teachers were in attendance. It was to help teachers utilize the Museum's resources that the first formal educational program, a series of slide-illustrated lectures, was started in 1880.

This past year close to 600 teachers earned college credits by completing courses on a wide range of subjects including "Primitive Religions," "The Educational Values of Our National Parks," and "Wildflowers of Forest, Meadow, and Stream." This program, organized in conjunction with The City College of New York, offers between 20 and 30 courses designed for teachers of all grade levels. The classes meet once a week for 15 weeks, and have an enrollment of from 15 to 200 students. A nominal registration fee is charged.

Every year adults with special interests are offered a number of evening courses consisting of a series of from six to eight illustrated lectures, with a faculty drawn from both the education and scientific departments. Fees for the courses range from $12.00 to $16.00 The classes vary in size from the record 1,000 a night that turned out for Dr. Margaret Mead's "Peoples of the Pacific" series, to small groups of 15 or 20. Always popular are the series involving field study, i.e., the Saturday "Field Walks in Geology and Botany," the "Morning Walks in Central Park," and "Natural Science for the Layman."

Three programs for adults, all without a fee, are the weekly film programs, the gallery talks, and the slide talks presented on weekday afternoons. Topics are listed in advance in the monthly *Calendar of Events*, and also in brochures distributed by the Department. These programs reach an older audience than do many of the Department's offerings. A large proportion of the audiences returns repeatedly, and the teachers soon find they have a "following."

A program expressly for older persons is the "Golden Age" program, organized for the Welfare Department's Day Centers. About 20 groups a year are accommodated, and the staff finds the men and women enthusiastic and appreciative.

PROGRAMS FOR INDIVIDUAL STUDENTS

Not all of the valuable work being done by the Department of Education is concerned with groups; much is done for individuals.

Saturday classes for young people are given for students aged 8 to 17. This spring eight courses are being offered, including ones in marine biology, archeology, wilderness areas, and fossils and their meaning. The Department has 16 scholarships available for children unable to pay the nominal fee charged.

A grant from Texaco, Inc. supports "Principles of Geology," a 10-session Saturday morning course given for several years now to students selected by the local high schools. As part of the course the 20 or so students are taken on all-day field trips to quarries and other geologically significant points.

Another program for the individual students is carried out in the Calder Laboratory, a part of the Natural Science Center. There, under the supervision and guidance of a teacher, as many as 12 students, aged 8 to 16, may work on their own projects in the field of natural science, projects first submitted to the Center staff for approval.

Since the Science Center opened in 1954, it has been a mecca for youngsters, so persistent at times that the staff inaugurated a student training program. Some of these students have graduated, so to speak, and are now participating in educational programs given by the Museum's scientific departments.

Although high school students may apply for research work at the Museum on a volunteer basis, most applicants for two federally supported programs, the Undergraduate Research Participation Program, and the Urban Corps Work-Study Program, are from colleges.

Undergraduate Research Participation is completely sponsored by the National Science Foundation (NSF). Designed to interest top-grade college science students in research and the continuation of their studies in graduate school, it operates in all research fields at the Museum, from anthropology to zoology. The Museum accepts 25 to 30 students a year, about 10 per cent of the total number of applicants. The students work directly with Museum scientists on research projects, collecting and analyzing data, interpreting. developments, and writing reports. Some of the reports have been published. Most of the students are here for a summer, and receive a stipend of $600. Others from tri-semester schools come during work terms, and a few enter the program on their own time.

The Urban Corps Program was started in the summer of 1965 for college undergraduates and graduate students. Urban Corps "interns" are supported primarily through federal funds appropriated under the Higher Education Act of 1965. The city puts in about 10 per cent of the costs. Last summer 35 students worked in 13 departments. Their work, while the same as the NFS-supported students, was oriented, however, toward a future in federal or city jobs after finishing their education.

At a higher level, courses for advanced undergraduate and graduate students are taught in the Museum by staff members who have adjunct appointments in local universities. Today, more than a dozen students are being guided in doctoral research by Museum scientists. Several departments have postdoctoral workers as well.

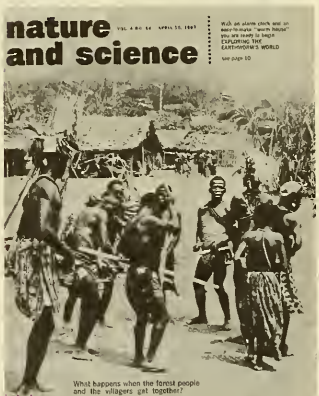
Young scientists doing research in phases of wildlife conservation or North American natural history related to the Museum's work have been aided by the Theodore Roosevelt Memorial Fund. Started in 1961, the fund has brought grants of from $200 to $1,000 to about five scientists each year.

The Museum has been offering grants to graduate and postdoctoral ornithologists since 1951, when the Frank M. Chapman Fund was begun. The fund is designed to "support and foster research in ornithology from a broad and international point of view." About 20 per cent of the grants were awarded to scientists outside the United States.

About a dozen Ogden Mills Fellowships have been granted to anthropology specialists since the fellowship was set up in 1960. The grants usually go to postdoctoral candidates. Two grants of $5,000 apiece are awarded each year.

TV personality Hugh Downs is among adult students who have taken courses at The American Museum-Hayden Planetarium. At left, he participates in a telescope-making class.

Dr. Thomas D. Nicholson (above), Chairman of the Planetarium, teaches the use of a sextant to student at a navigation class in the Planetarium. Reproduced at right is a NATURE AND SCIENCE *cover showing the lively format that makes the magazine so popular with youngsters. At far right, student releases a marked turtle as part of an animal behavior study conducted at Kalbfleisch Field Research Station on Long Island.*



EDUCATION THROUGH THE WRITTEN WORD

The Museum also strives to dis- əminate its knowledge through the ritten word. *Natural History* maga- ine made its debut 68 years ago and ɔday attracts an audience of nearly 00,000 readers, ranging from the pper echelons of the scientific com- iunity to school groups and laymen. he magazine's scope has broad- ned to encompass contemporary ubjects relevant to an understand- ıg and appreciation of all aspects f natural history.

In 1962 a new publications divi- ion, The Natural History Press, was ırganized in conjunction with)oubleday and Company, Inc., and ɔ date has produced 59 books. All ıreas of science are the province of he Press, as indicated by a variety ıf titles including: *Future Environ- nents of North America, These Fra- ;ile Outposts, A Geologist's View of ;ape Cod, Africa and Africans, Bi- ›logy of Birds, The Archaeology of Vew York State,* and *Invitation to \nthropology*. Books are written by Museum scientists and others prom- nent in their fields. While most of he 650,000 books sold through The Natural History Press have been on he adult level, middle and upper ılementary school grade levels have esponded very strongly to the "As- ronomy Highlight Series" written by scientists at the American Museum- Hayden Planetarium, and to books such as *Discovering Rocks and Minerals.*

Nearly a quarter million young- sters read the semimonthly maga- zine *Nature and Science,* also pub- lished by the Press, which goes to schools and homes on a subscrip- tion basis. Now in its fifth year, this magazine shows how scientists study living and non-living things, and suggests ways for children to make their own investigations of nat- ural phenomena. A special Teacher's Edition provides background and suggestions for classroom use.

LEARNING AT THE AMERICAN MUSEUM-HAYDEN PLANETARIUM

In a separate wing of the Museum, the American Museum-Hayden Planetarium maintains its own staff of 25 full-time, part-time, and special instructors. Its popular daily lecture in the Sky Theater dome, aimed at young people, attracted 172,000 pupils in 3,400 school groups last year.

Four special Saturday courses were given in series of 5 and 10 sessions each, attracting another 200 children. "Astronomy for Young People" and "Special Topics in Astronomy for Young People" are among the series offered under this program. A summer course, "Junior High Laboratory in Astronomy," is given for .the higher elementary grades.

The Planetarium offers an intensive 5-week summer course, "Astronomy and Space Science," for high-ability high school students. So far, 1,200 area students have taken the course, which is free and sponsored by NSF grants. Twenty lectures are held, ranging in scope from "The Electromagnetic Spectrum" to "Dynamics of the Solar System" and "Astrometrics." It is considered the most ambitious high school course offered at the Museum.

The Planetarium also provides a variety of lecture and workshop classes to the public, among them "Earth and the Solar System," "Sun, Moon, and Stars," and "How to Use a Telescope."

But the real educational triumphs of the Planetarium are the famous "sky show" and the 40-minute lecture that accompanies it. About 600,000 people saw the show last year and learned about the changing patterns of stars and planets, the whys and why-nots of their existences, about the moon and man's attempts to reach it, the sun and what it does for the earth, and the shrinking world of space.

EDUCATION— ALIVE AND EVER GROWING

The education system that lies beneath everyday activities at the Museum is somewhat like a coral reef. Only a relatively small fragment of the whole is seen above the water's surface. The greatest part lies underneath where living creatures work constantly to expand and strengthen the reef.

For nearly a century far-sighted educators have developed programs for people of all ages and all backgrounds, with all kinds of needs—programs to encourage and guide them through the richness that is the Museum, a vital door to the natural world.

DR. FRANKLYN M. BRANLEY

A decision made by Dr. Franklyn M. Branley almost 12 years ago may have been one of the most important steps in the development of education in the American Museum-Hayden Planetarium. In the fall of 1956, he left the teaching profession after 20 years of experience and joined the Planetarium staff. The decision to move here was "a big one," Dr. Branley admits, since, up to that time, his whole life had been wrapped up in teaching. Today, his responsibilities are varied and vital as Assistant Chairman and coordinator of education in the Planetarium.

The administration has given their education expert a free hand to initiate and develop programs. Dr. Branley believes many of today's successful education programs at the Planetarium are the fruits of his early labor. These include: workshops in astronomy for teachers, college-level background studies for teachers, courses in collaboration with nearby colleges and universities, informal open-houses for teachers, laboratory courses for elementary teachers, and an exciting summer program in astronomy and space science for high-ability secondary school students.

Dr. Branley contends that "the Planetarium should be a liaison between the community and the professionals, to interpret what the professionals are doing for the laymen." One of the most effective ways of doing this is through the teaching community, where he obtained his early experience. "Through the teachers," he points out, "you reach the vast audience of young people and their families."

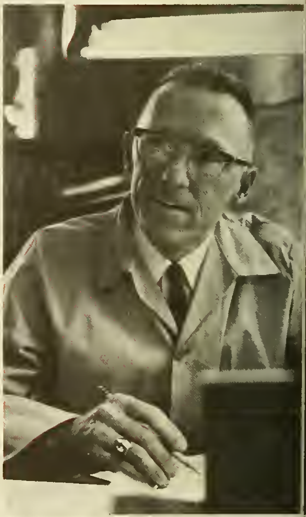
Dr. Branley was born in New Rochelle, N.Y., and received his bachelor's degree from New York University, his M.A. and Ed.D. from Teachers College of Columbia University. Before moving to the Museum he held teaching posts at all levels, from grade school to college.

Dr. Franklyn M. Branley

Dr. Edwin H. Colbert

MUSEUM PERSONALITIES

Dr. Wesley E. Lanyo



Catherine M. Pessino

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)R. EDWIN H. COLBERT

Dr. Edwin H. Colbert, Curator and ɔrmer Chairman of the Department f Vertebrate Paleontology, has deoted so much of his time and enrgy to The American Museum of latural History that today he says the Museum is my life." He joined ıe Museum in 1930 as a research ssistant to President Henry Faireld Osborn, and has remained here ver since. Respect for his work has ontinued to increase over the years, ɔ the point where he is now widely egarded as one of the most eminent ıen in his field.

In 1966, he gave up the chairmanhip of the department in order to levote more time to research work.)r. Colbert says his retirement is not far off," and he has stacks of lata and an abundance of knowledge he wants to organize and write efore he leaves the Museum. His rimary interest is in Triassic repiles, a category that involves extenive field work. Recently he spent a nonth in the field while he was in South America attending the Gondvana Symposium and the Continenal Drift Symposium.

Dr. Colbert has focused much of his attention on fossil remains in North and South America and Asia. His research has shed light on the problems of past distribution and ntercontinental migrations of landiving vertebrates, and his expeditions have produced important fossil finds.

Dr. Colbert has been teaching on the staff of Columbia University since 1945 in a special graduate program conducted in The American Museum of Natural History. He is currently teaching the Evolution of Fossil Amphibians and Reptiles to graduate students. He was responsible for starting *Curator*, the Museum's quarterly technical journal on museum philosophy, techniques and practices, in 1958, and served as editor of the magazine until 1964. In addition, his bibliography of published books and scientific papers numbers 262 articles.

He was born in Clarinda, Iowa, and received his B.A. from the University of Nebraska in 1928. He earned his M.A. and Ph.D. from Columbia University.

DR. WESLEY E. LANYON

Without the foresight and concern of Dr. Wesley E. Lanyon, Curator in the Department of Ornithology, the Kalbfleisch Field Research Station in Huntington, L.I., might never have become the education center it is today.

Dr. Lanyon was responsible for recognizing the potential of Kalbfleisch, and for seeing that it was realized. When the property was willed to the Museum in 1957, he suggested that it be turned into a field research unit, the only one within reasonable commuting distance of Manhattan.

In 1958, just a year after he joined the Museum, he was named Resident Director of Kalbfleisch, a position he still holds, and began the extensive work of renovation and alteration of facilities, with the cooperation of other Museum staff members. His jobs were to parcel out land on the 94-acre tract, coordinate scientific activities, and give shape to long-range plans.

In 1960, the first college students came to the station for summer programs under the Undergraduate Research Participation Program, sponsored by the National Science Foundation. Now, Kalbfleisch is the center for research by between 9 and 12 undergraduates every summer. The students receive room, board and a $600 stipend, as well as expert tutelage in field biology and astronomy. Also two or three high school students are accepted as volunteers every summer. Dr. Lanyon and Dr. Donn E. Rosen, Chairman of the Department of Ichthyology, are currently investigating possibilities for beginning a graduate program.

Dr. Lanyon lives year-round at the station with his wife and two children. A graduate of Cornell University who earned his Ph.D. at University of Wisconsin, he taught zoology at the University of Arizona and the University of Miami in Ohio before joining the Museum. His extensive field work includes five summers as a naturalist with the National Park Service, studies in North and Central America, and the West Indies.

CATHERINE M. PESSINO

Miss Catherine M. Pessino is a veteran of the Museum's Education Department, and has been head of the Natural Science Center for young people since 1960. She was one of a group of department members who urged that the Center be established in the early fifties, and she was active in programs from the time it was founded in 1954 until she was named to the top position six years later.

The aim of the Center is to teach New York youngsters about geology, plant, and animal life of the Manhattan area. Under Miss Pessino's guidance, programs have been developed that combine standard educational practices with an original, exciting approach. She presents live, colorful exhibits, ranging from a tropical lizard mysteriously found wandering around Central Park, to starlings, garter snakes, pussy willows and dandelions. The children are guided by mimeographed quizzes, question periods, and specimen studies, to round out the experience.

Miss Pessino is also in charge of the Louis Calder Natural Science Laboratory, an adjacent room where young people can work on their own special projects, and she points with pride to the enthusiasm of the neophyte researchers.

An active worker on her own, she cooperated recently with the city's Board of Education on a project involving neighborhood field walks for children, and filming of the trips for in-school use. She is engaged in research at the Museum's Great Gull Island in Long Island Sound, where studies are under way on the breeding and biology of two species of tern. She is chairman of the Great Gull Island Committee, and was influential in establishing the research program there.

A native New Yorker, Miss Pessino received her B.S. degree from Hunter College. She has traveled extensively, and has collected Mexican, Southwestern Indian and Eskimo materials for use in the Museum's education programs.

BOARD OF TRUSTEES

FINANCIAL STATEMENT

Operating expenses of the Museum taled $6,258,647 against which there as income of $6,223,838, leaving a defit for the year amounting to $34,809.

One-third of the expenditures ($2,045,-i5) were made in connection with speal programs or projects for which inome had been provided through rericted endowment funds, contributions, ·ants and other sources. The exhibition all rehabilitation program, research fianced by governmental granting agenes, publication of professional papers, peration of the field stations and adult ducational projects are the principal eas benefiting from the funding of ese activities by friends of the Museum.

The remaining two-thirds of the expentures ($4,212,852) were used in connecon with the regular budgetary operaons of our general funds. These inuded expenses of general administraon, educational activities, operation nd maintenance of the physical plant, ensions and other employee benefit osts. These expenses were financed by n appropriation from the City of New ork, income from unrestricted endowent, membership dues, sales, services nd the generous financial support of ustees, members and friends.

The fiscal year ended June 30, 1967, as been an encouraging one financially or the Museum. Additions to the endowent funds received through gifts and equests resulted in an improvement of ie yield from these funds. As a result of ur annual fund raising drive, gifts and rants reached an all time high of $314,-00. Without this generous support, the perating deficit would have been $349,-09. We wish to express our appreciation o all those who have supported the work f the Museum. Additional funds are eeded for our expanded exhibition hall rograms and to meet the continuing ising costs of operations. We are grateul for past assistance and hope for your ontinued interest and support in the oming year.

EXPENSES AND RESERVES

1 EDUCATIONAL ACTIVITIES: Curatorial supervision, research, exhibition, education, publications, library and field stations	$3,732,134	59.63%
2 OPERATION AND MAINTENANCE OF PHYSICAL PLANT: Guarding and cleaning, building construction and maintenance and other expenses	$1,349,346	21.56%
3 GENERAL ADMINISTRATION: Administration and general supervision, business offices, public relations, membership and general expenses	$ 722,375	11.54%
4 PENSION AND EMPLOYEE BENEFIT PAYMENTS: Museum's share of pension costs, social security, life, hospital and medical insurances	$ 454,792	7.27%
	$6,258,647	100.00%

INCOME AND DEFICIT

1 ENDOWMENT INCOME	$1,858,932	29.70%
2 APPROPRIATION FROM THE CITY OF NEW YORK	$1,851,776	29.58%
3 GIFTS AND GRANTS	$1,053,111	16.83%
4 OTHER INCOME: Membership dues, sales and services, grant overhead, field stations, net proceeds from Natural History magazine and Museum Shop	$1,108,945	17.72%
5 TRANSFERS FROM RESERVES FOR RESTRICTED PURPOSES	$ 351,074	5.61%
6 OPERATING DEFICIT	$ 34,809	.56%
	$6,258,647	100.00%

THE AMERICAN MUSEUM OF NATURAL HISTORY / CENTRAL PARK WEST AT 79th STREET / NEW YORK, NEW YORK 10024

Dear Mr. White:

Here is my contribution to help The American Museum of Natural History in research, education, and exhibition.

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CELESTIAL EVENTS

The moon is in the evening sky until March 14; in the morning sky thereafter. First-quarter moon occurs on the 7th; full moon on the 14th; last-quarter on the 21st; and the new moon on the 28th.

Mars, Jupiter, and Saturn are evening stars, but only Jupiter is easy to see. It is well above the horizon in the east at dusk, conspicuous among the stars of Leo, and sets a little north of west before dawn. Venus may be seen low to the south of east just before dawn brightens. Mercury, a morning star close to Venus, is much fainter.

March 1: If you can see the slender crescent moon in this evening's sky, look just below it to find Mars and Saturn.

March 4-5: Mars and Saturn are in conjunction at midnight on the evening of the 4th. They are close together, but set too early both nights to be readily seen.

Jupiter is quite close to the bright star Regulus. Conjunction is at 2:00 A.M., EST. If you can find Venus low in the morning sky, very bright, just at daybreak, the star-like object seen just above it is Mercury.

March 12: Jupiter appears to the right of the bright gibbous moon in the early evening sky, slowly separating from the moon as both move toward the west.

Mercury is at greatest westerly elongation this day and may be seen low in the east in the morning sky for several days before and after.

March 20: The sun arrives at the vernal equinox at 8:22 A.M., and spring begins in the Northern Hemisphere.

March 31: Mercury and Venus are in conjunction again, but both planets are too close to the sun to be seen.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on March 1; 8:30 P.M. on the 15th; 7:25 P.M. on the 31st; but it may be used for about an hour before and after those times.

Ill Shapen Beast by *Fred Bruemmer*

On June 17, 1689, Henry Kelsey, exploring the region north of the Churchill River and west of Hudson Bay for the Hudson's Bay Company "spyed two buffilo . . . ill shapen beast Their Body being bigger than an ox . . . . their Horns not growing like other Beast but Joyn together upon their forehead and so come down ye side of their head and turn up till ye tips be even wth ye Buts. Their Hair is near a foot long."

He was the first white man to see and describe muskoxen, the shaggy ungulates of the Arctic regions of Canada and Greenland. They were numerous then. Nearly a century later Samuel Hearne, on his trek from Churchill to the Arctic Ocean, frequently saw "many herds of them in the course of a day's walk, and some of those herds did not contain less than eighty or an hundred head."

The principal enemy of the muskox is the wolf. When threatened, the animals of a herd crowd together into the "hedgehog formation," a circle or semicircle, with calves and young animals in the center, while the adults turn their sharp, curved horns toward the attacker. Should an incautious wolf approach too close, a muskox will rush out, try to gore and trample it, and then return to its place in the defensive circle. This strategem works well against wolves, but in encounters with men and rifles it is suicidal.

The Eskimos have always hunted the muskox. The meat has been compared to beef. From the animal's long guard hairs the Eskimos made mosquito nets, and out of the keratinous sheath of the great horns they carved ladles, prongs for their fishing spears, and toggles for dog harnesses.

The Eskimos with their primitive weapons killed relatively few muskoxen. But the advent of white men and guns spelled doom for this slow-reproducing, ungainly creature that refused to flee. Bowhead whalers from Scotland and New England wintering in Hudson Bay shot thousands to provision their ships. Muskox robes became a valuable trading item, and between 1862 and 1916 the Hudson's Bay Company alone bought more than 15,000 of these pelts. Arctic explorers often depended largely upon muskoxen for survival and success. Between 1880 and 1917 American and Norwegian explorers killed more than 1,000 muskoxen on Ellesmere Island (the northernmost point of Canada). Still later, the capture of calves for zoological gardens made heavy inroads on the already depleted herds. The method of capture then was simple and brutal. All adults of a herd were shot to get the calves.

By 1917 muskoxen had become so rare the Canadian government ordered their complete protection. Of the Barren Ground muskoxen (*Ovibos moschatus moschatus*) on the North American mainland only an estimated 500 survived. The northern subspecies of the Arctic islands and Greenland (*Ovibos moschatus wardi*) had also

been severely reduced in numbers.
Since then the animal has made a slow but steady comeback. The Barren Ground muskox has tripled its numbers in 50 years to an estimated 1,500. On Canada's Arctic islands there are now about 8,500 muskoxen, most of them (approximately 4,000) on Ellesmere Island.
The muskox' scientific name, *Ovibos moschatus*—the musky sheep-ox—is somewhat misleading, since it is neither ovine nor bovine nor, according to most observers who have come within smelling distance, musky, except for bulls in rut. Its closest living relative is the takin, which inhabits mountainous regions in Tibet, Burma, and China
Short-limbed and massive, cloaked in an immense double-layered fur coat, the muskox seems impervious to the worst weather the Arctic can offer. Over much of its range, extending from the Arctic mainland to the extreme northern tip of Ellesmere Island, the mean January temperature is 30°F. below zero and February isn't much warmer. Temperatures can drop to nearly 70°F. below, and storms last for days. But the muskox endures all and manages to survive the wintry darkness of its northern range.
Instead of seeking shelter in valleys, muskoxen prefer the exposed, wind-lashed slopes, where shallow snow cover makes it easier to reach the scant vegetation. In a storm the animals crowd together, hindquarters to the wind, sheltering the calves within this furry rampart.
Underneath the shaggy dark-brown mantle of long outer guard hairs hanging nearly to the ground, the muskox wears a thick layer of downy wool. In spring this underwool, called *qiviut* by the Eskimos, begins to come off in large patches, works its way through the outer hair, and trails the animals in long yellowish streamers, so that they look weirdly ragged and motheaten.

The calves, born in April and May, enter a hostile world. Temperatures can still be 20° or 30°F. below zero, yet such a frosty welcome seems to have little effect upon them. They already wear a thick curly wool coat and thrive on their mothers' milk—rich in fat, protein, and lactose. Within a week they begin to nibble plants, but stay with their mothers for at least a year and a half. The cows mature at the age of three (bulls at about five years) and usually bear only one calf every two years.

The battle of the bulls for possession of the herds is primitive and impressive. During the rutting season when a bull approaches a herd, the lead bull will march out slowly to meet him. At twenty or thirty paces from each other they halt. Suddenly, as upon a signal, the 800-pound bulls charge, smashing their heavily bossed heads together with a crack that can be heard a mile away. Then they return to their prior places, wait a moment, and charge again. They keep this up until one contestant, dizzy and weakened, flees. Bulls who have been driven from the herds by stronger rivals become solitary wanderers.

When not disturbed, the muskox' movements are slow and stately, in keeping with his massive appearance and his short legs. But when attacking or in flight, he is amazingly fast and can make nearly right-angle turns in full gallop.

In the Pleistocene, muskoxen wandered over much of Eurasia and North America. Fossil remains have been found in Europe as far south as the Pyrenees and well within the present continental United States. When the climate became warmer, the muskox followed the retreating ice northward and finally died out in Europe and Siberia, although they survived on portions of the Canadian Arctic archipelago and in Greenland.

In 1930, 34 muskoxen from Greenland were released on Nunivak Island, off Alaska. By 1952, they had increased to 77, and in 1962 there were 340 muskoxen on the island. Two other transplants of Greenland muskoxen have also been successful. About 100 muskoxen live on Spitsbergen, north of Norway, and some 30 in the Dovrefjell Mountains of Norway itself.

The muskox is now completely protected throughout its range—in Canada since 1917, in Greenland since 1951, and in Norway, on Nunivak, and on Spitsbergen since their introduction. In the spring of 1967, however, the Northwest Territories Council, against the advice of government biologists, decided to permit the shooting of 32 muskoxen annually by sportsmen. The price: $4,000 per muskox. Even at that, applications arrived from as far away as Europe. There was considerable public opposition to this plan, and even hunters agreed that shooting muskoxen, which stand stolid when approached, could hardly be called sporting. As Vilhjalmur Stefansson put it so neatly: "the word 'sport' has a curious meaning when applied to killing muskox. . . . I would say that equally good sport could be secured with far less trouble and expense by paying some farmer for the permission of going into his pasture and killing his cows." Last October the Council announced it has abandoned its plan to allow the annual "harvest."

Fifty years of protection in Canada have permitted the muskox to slowly increase its numbers and to spread gradually back into areas where it had previously existed. Braving cold, storms, and distance, and now free from the depredation of man's destructive pastimes, the muskox is slowly regaining the former extent of its frigid realm.

PART 2

ETHIOPIA by Alan Ternes

A woman burdened with a heavy load of firewood or a clay jar of water is a frequent and, at first, unfathomable sight along the modern highways of Ethiopia. Why, you wonder, doesn't she use a wagon or even a crude wheelbarrow to shed the weight from her back?

The burden—senseless by modern standards—is a visible sign of the strict bondage of millions of Ethiopians to their culture. The failure of many rural Ethiopians to use the wheel is one of countless ways their toils and thoughts reflect the isolation of their past, lived out amid the barriers of rugged mountains and valleys.

The physical and cultural barriers against modernization persist and plague the planners of the central government. Progress in recent decades is evident only in the major cities and at a few showcase plantations; most Ethiopians have barely been touched by change.

Even today, no clear picture of the country or its problems exists because basic statistics are unreliable or non-existent. For example, Ethiopia's population is unknown because there has never been a complete census. Estimates vary as much as five million above and below the most reliable figure, for 1967, of slightly more than 23 million persons. The capital, Addis Ababa, has a population of about 500,000.

Problems of development are compounded by a dual economy. In the cities business transactions are conducted in Ethiopian dollars, but for the 90 per cent of the population in subsistence agriculture most business is conducted by barter in local markets. Any attempt to calculate the value of barter transactions can be little more than a guess.

Land ownership and rights to the land are also unclear. Agreements between landlords and tenant farmers are not written and remain controlled by custom. In one pilot study on a highland plain about one-half of the land was privately owned, one-third owned by the church, and much of the rest owned by the government. Even these conclusions had to be made from interviews at a district headquarters, rather than through actual field studies, because farmers and landowners resent any attempts to measure the exact boundaries between plots or to compute landholdings precisely. In many cases the size of a plot will be related to its productivity, so that plots of different sizes are considered equal.

Because of the lack of reliable data about the people, the economy, and the land, and because of the lack of accurate maps, geographic interpretation of Ethiopia can be little more than a superficial survey.

Possibly because maps are flat, geographers tend to view places horizontally. A more fruitful approach for Ethiopia is to look at areas vertically. For example, the landscapes, the economics, and the daily lives of Ethiopians on the two highland plateaus are similar, while all these elements differ greatly on the floor of the Rift Valley between the plateaus. Unlike the vertical distribution in most countries of the world, in Ethiopia three-fourths of the leading cities and villages are located at elevations of 5,000 to 11,000 feet. In the United States 44 of the 50 largest cities are below 1,000 feet and only one, Denver, is just above 5,000 feet.

The cool, green highland plains, or *ambas,* appear to have been manicured by man. Almost every level or gently sloping plot is used, mainly for grains or grazing. The soils are rich and easily tilled; rainfall is abundant and is distributed through regular seasons. The only numerous trees of the *ambas* are eucalyptus planted in woodlots for fuel and lumber, scarce commodities in Ethiopia. The vigorous, rapid-growing eucalyptus, an Australian import, has become the dominant tree near heavily populated areas.

The only abundant wildlife are creatures that coexist successfully with man, such as the blue-eared glossy starling, hooded and Egyptian vultures, baboons, and the ubiquitous hyenas. Even in Addis Ababa hyenas occasionally skulk through the streets at night while frightened dogs howl from the safety of nearby houses.

The typical Amhara farmer of the highland plains—tall, keen-featured, draped in brown flax robe—exists in a closed world of circles of space and cycles of time closely tied to the seasons and the Ethiopian Coptic Church.

The smallest spatial circle is his home, traditionally a round, mud and manure building with a thatched roof. Inside, a partition separates the inner living area from the rest of the house. At night cattle are brought into stalls in the outer circle of the house for protection and warmth. Around the house the farmer constructs a thick, circular fence of thorny bushes. Houses are often found in clusters, with another tall, circular fence of thorny brush around them.

An Ethiopian farmwife spreads hand-washed clothes in the sun to dry along Lake Haramaia in the highlands near Harar.

Adorned with silver headband and bracelets, a Moslem woman (below) strides through the market at Harar. The women in the region observe most Moslem customs but do not wear veils.

Warm robes of Amhara farmers in a busy market in the highlands of Shoa Province (center) contrast with the light, colorful dress of a woman sitting shaded from the sun in a lowland market near Jijiga, on the road to the torrid Ogaden Desert.

A Galla girl (right) pauses to adjust her bright costume and jewelry. The circular, thatched mud and manure homes (below) hold family and livestock of farmers in the Ahmar Mountains. A Somali woman (bottom) scoops water for her cattle from a man-made seep hole.

The Ethiopian farmwife spends most of her life in toil, which begins in predawn darkness each morning when she rises to grind grain. In the first of her endless round of chores, she uses a flat stone to pulverize the rough kernels of teff, an endemic plant grown only in the highlands. The flour is mixed into a sour dough, which is baked into large, flat pancakes called *injara,* the basic food of the Amharas.

The husband rises at dawn, recites a morning prayer, and leads the oxen, cows, donkeys, and mules from the house to pasture. He then returns and, sitting on a sheepskin spread over a clay bench along the inner wall of the house, eats his breakfast of *injara* and hot pepper sauce. On most days he goes early to his fields with his oxen while his sons herd the cattle. With a crude, iron-pointed plow, each of the farmer's fields is turned over twice for each of the two or three crops grown yearly; first to break the soil and then to cover the hand-sown seeds of teff. Harvesting of the low teff plant is painfully slow and is done with small hand sickles.

At dusk the farmer and his sons return to the home, and once again the family encloses itself in the circular house. After his evening prayers the farmer retires to a low handmade bed of wood and cowhide strips. The children lie down on the sheepskin-covered clay benches. The last to retire is the mother, who covers the embers of the fire with ashes and sets out the grain she will grind in the morning.

The daily cycle of toil is broken only on Saturdays, Sundays, and religious holidays, when the Amharas refrain from labor and regularly walk long distances to church. Additionally, once a week the wife may walk five or ten miles to a nearby village on market day to barter eggs, chickens, and grain for household needs, such as salt or pepper.

The Ethiopian farmer does not deviate from the binding traditions of his father and his father's father. He sees no reason why his sons should not follow the same patterns.

In a few places changes are appearing in these traditional patterns of life. More and more children are attending school, as the government tries to remove the handicap of illiteracy from more than 90 per cent of the population. Many members of the U.S. Peace Corps are stationed as teachers in isolated villages, and their influence on the minds and horizons of young Ethiopians is great. Also, the movement of people, products, and ideas has increased as air travel and road networks have grown in recent decades. Low-cost buses on high, rugged chassis rumble along the roads and facilitate the growing movement of laborers toward the urban areas, especially Addis Ababa. The national carrier, Ethiopian Airlines, which began operation in 1946, now serves forty cities and villages throughout the country. In addition the international network of its modern jets touches seventeen countries in three continents. The airline brings a growing number of tourists to the country, and this has had profound effects on the attitudes toward foreigners and foreign ideas. But an airline network has, by its nature, only a spotty influence, and leads to the development of little islands of modern influence amid an otherwise primitive landscape.

The growing system of roads has been fostered by the government primarily to increase the export of goods, particularly coffee beans. Modern bridges span the once-impassable gorges, and all-weather roads now tie the formerly subsistence local economies into the national market. The financial advantages of a modern highway are tremendous: the 208-mile trip between Addis Ababa and Jimma in western Ethiopia took two weeks in 1953, with freight costs of \$45 a ton; today the trip takes eight hours, and freight costs \$20 a ton.

In the small markets along these modern roads manufactured goods are appearing: empty tin cans, which sell for 10 cents apiece; nails and tools; aluminum pots; cotton goods from India and Japan; plastic shoes from Italy; chewing gum from the United States. The traders sell these goods for cash, which tends to force the rural peasants more and more into the national economy.

In the evergreen montane forests in lower areas of the plateaus is grown the country's leading item of foreign trade—coffee. Like many aspects of Ethiopia, the methods of coffee cultivation range between two extremes, from modern plantations run by foreigners or Ethiopians educated abroad, to primitive practices closely related to those of food gatherers.

In the primitive systems, the original montane forest is not destroyed, and the coffee plants germinate from fallen seeds. The only cultivation by farmers living nearby is to cut back competing shrub vegetation. In cases where coffee plants have not spread to an area naturally, the "farmer" simply pulls up coffee seedlings from a crowded plot and pushes them into stick-made holes. They usually survive. When the coffee is ripe, the cherries with the coffee beans inside fall to the ground. The cherries are carried back to the villages, where they are spread on packed, bare ground to dry before being sold to traders at a local marketing center.

The primitive method has many disadvantages: low productivity; poor quality of bean because of the methods of harvesting and drying; and beans of different sizes and types. But for the Galla and other tribesmen of the remote montane forest the method has one great advantage; it does not require investment.

The large coffee plantations maintain nurseries to control plant breeding and selection. Competing vegetation is cleared, except for a few canopy trees to shade the coffee bushes. Plants are evenly spaced and pruned to give them a bushy shape so that the cherries may be easily picked when ripe. Migrant laborers spread canvases on the ground to catch cherries during the harvests. These are dried by machine and stored in odor-free warehouses within a few hours after being removed from the bushes.

As much as 500 pounds of high-quality coffee per acre is grown on the plantations, a yield at least five times as great as that of the primitive method. However, the plantation method requires considerable

investment, managerial skills, and a dependable supply of labor—all difficult to obtain in Ethiopia.

Nevertheless, plantations each year produce a larger proportion of the exportable coffee and the importance of the semiwild harvesting is reduced. As the low-grade beans lessen in value, the ties of the coffee-gathering peoples with the outside world will diminish, and the more remote tribes in the wilder valleys probably will return to the completely subsistence food gathering and simple agriculture of their ancestors.

The power of the harsh environment of the Rift Valley can be felt fully in the rugged, one-day trip from the edge of the Somali Plateau, about 200 miles east of Addis Ababa, to the banks of the Awash—a distance of about 100 miles. The light vehicular traffic along this route compressed the soil on the bare surface of the unpaved road. The Rift Valley is normally arid, but during the rainy season storms roll down from the plateau with torrential rains. Today most of the road is impassable because of the deep gullies that have eroded into it. The existing track zigzags back and forth over an old one built thirty years ago, during Italian occupation, and often splits into several branches, depending on the whims of previous drivers over the route.

The road is now only used by an occasional supply truck or police vehicle. During a drive over the route in 1967, we found that ours was only the second private party to use the road in two years. Yet this track is the main link of several hundred square miles of the Rift Valley with the outside world.

The track strikes out from Errorgota, a village near the northern edge of the Somali Plateau that contrasts greatly with its surroundings. The land at the village is owned by the emperor, and with the aid of irrigation has been turned into a large citrus plantation with lush plant life. But just north of Errorgota the vegetation changes rapidly; stunted shrublike trees give way to grassy savanna. Thereafter, the only trees are found in narrow strips of gallery forest along streams that drain from the sides of the plateau toward the Awash River. These streams disappear in the sand before they reach the Awash, but riverbeds and trees extend beyond the last of the running water, and if you scoop a deep hole in the middle of a dry riverbed and wait, it may fill slowly with potable water.

A few miles before reaching the Awash, the land is practically barren, and to the east you can see the tan dunes of the Danakil Depression. Only widely scattered Danakil tribes survive there, and by reputation and deed they are as fierce as the landscape.

The Awash in the middle of the valley is greatly diminished from the mighty river that roared down from the edge of the plateaus; it is sluggish and sediment filled. Marshes with crocodiles and hippopotamuses line its sides. A hundred miles farther east the river oozes into a marshy lake and dies.

The nomadic tribes of the Rift Valley and other arid regions of Ethiopia are mainly Somalis. Their languages, their Moslem religion, their tribal customs, and their nomadic life set them apart from the main trends of Ethiopian life. In the Ogaden Plain of the southeast, where Ethiopia borders the Somali Republic, the tribes ignore political boundaries as they search for water and fresh grass for their goats, cattle, and camels. This has led to a series of disputes and political negotiations over the border problem. Meanwhile, the nomadic tribes continue the life they have known for centuries—long before nationalism and state boundaries were significant in Africa.

Modern civilization in the middle of the Rift Valley is represented by the police post, which is like an army camp. The post at Osboli has about 200 persons, including the families of the policemen, and is surrounded by a stone wall with rifle and machine gun emplacements. The policemen and their pack of noisy dogs seem to be guarding an empty world, except for some vultures and storks scavenging at the site where a cow purchased from the Somalis is butchered every other day to supply the post with fresh meat.

One night the commander, a friendly lieutenant who admires the FBI, looked out across the moonlit plain and described for me some of the contact between this outpost of the empire and the nomadic tribes.

"We don't know where they are, what they're doing," he said. "One day I'll drive around and not see a single person for miles, the next day a whole tribe will suddenly be there. If there is some trouble, they suddenly appear from nowhere, and you see them behind every rock."

"Trouble" can assume serious dimensions, because later, far from the police post, we saw Somalis who have acquired modern carbines. They have also, I should note quickly, retained the Moslem tradition of hospitality and honor for guests, and we had no trouble once they understood we were friendly.

Most trouble occurs when two tribes dispute water or grazing rights and the police step in to stop the bloodshed. At other times a weak tribe will flee to the protection of a police post during a dispute with another tribe.

The villages of the nomads are groups of small

Helicopters of the U.S. Mapping Missi[...] forerunners of change for Ethi[...] most of whom now lead traditional, lo[...] rural lives, without national alleg[...]

four-foot-high huts made from grass mats. The base of the hut and a small yard are often marked out with low rows of volcanic rock. These rock outlines remain after the tribe moves on, and throughout the dry region of the Rift Valley you can see these silent remnants of past occupation.

Whatever water is available in the valley is used by nomads and their stock for drinking. Little is used for bathing and, as a result, the incidence of disease is high. Eye diseases, especially, affect many because sand and dust blows into their eyes, which are then rubbed by unwashed hands. Blindness is common, and one of the traditional tasks of young children is to lead blind elders.

The modern city of Diredawa, at the edge of the Rift Valley, grew at the beginning of the century as a rail depot for the shipment of coffee from the Harar highland district. It has now become the market for many Somali and Danakil tribesmen. Three highways and the Addis Ababa-Djibouti railroad converge at Diredawa, but most of the tribesmen who drive goats and cattle or who lead caravans of camels loaded with firewood to market do not use these arteries. They filter into the city on ancient caravan trails and dry riverbeds—routes most of the city people are unaware of. Just as Ethiopia has a dual economy, so does it have modern and ancient transportation systems.

For several months last fall Diredawa was the headquarters for a unit of the Ethiopia-U.S. Mapping Mission. Each day helicopters rose from the city and noisily clop-clopped across the Rift Valley, frightening the herds of animals and destroying briefly the tranquility of an ancient way of life.

The whirlybirds are portents of change, of the onrush of the modern world into even this hostile environment. As agricultural development schemes now being considered are carried out along the Awash River, using river and ground water for irrigation of the rich land, the niche for Ethiopia's nomadic tribes will contract, as has happened in other portions of the country. The isolation and independence of rural peoples will vanish as the country moves further along the path to economic development.

One dark night in the Rift Valley I heard a herdsman singing. The tune was not melodic, it was more a calling, at times almost a shouting of words and sounds into the night. Whether he sang for his cattle, for the hyena that yowled in the distance, or for the stars, I don't know. It was the singing of a free man.

The agricultural programs in the valley soon will pre-empt some of the best grazing and watering sites, and the new cotton and citrus plantations will need labor. The herdsman will be lured into a sedentary life by wages, medical care, and the promise of education for his children. But at night, what song will he sing?

Enigma on the Sea Floor

by O. C. Farquhar

The oldest writing known on earth goes far back, beyond hieroglyphs and other such pictorial methods. This writing is in the form of trails left by animals and later preserved as fossils. Such trails recorded in rock are of great value to scientists who probe the remote past. But sometimes they have additional usefulness; they can help us guess at the identity of a mysterious creature, also known only by its imprint, that still exists. In the words of the famous naturalist Ernest Thompson Seton, "Never forget the trail . . . it is the priceless, unimpeachable record of the creature's life. . . ."

This article deals with a comparison of just such ancient and modern trails, the former as ancient as the Cambrian Period some 500 million years ago, the latter as modern as the twentieth century. In both cases the trails show a "tire tread" pattern, nearly a half foot wide. The ancient fossil trails are preserved in rocks of eastern North America. The modern trails were formed in ooze on the floor of the Pacific Ocean, 8,500 miles away and a half billion years later.

It was in 1957 that a remarkably clear photograph of the ocean-bottom trail was taken with an underwater camera from the Russian research ship *Vityaz* at a depth of almost 10,000 feet. When the Moscow newspaper *Pravda* published the photograph four years later, several Western news media reproduced it, and in some translations the locale was given as the Indian Ocean, although *Pravda* had not mentioned a specific location. Actually, the photograph was taken at latitude 1°30′ N., longitude 154°07′ E., between the Caroline Islands and the Solomon Islands, in the western Pacific. This section, where the Pacific's greatest depths have been found, is now called the Vityaz Trench, after the Russian ship, which is well known in the Southern Hemisphere because of its far-ranging voyages.

The *Vityaz'* oceanographers had taken several photographs of the animal trails, which were subsequently described in a technical bulletin by two Soviet experts, O. S. Vyalov and N. L. Zenkevich. They also discussed various fossil trails, with which the Pacific one might be compared. An English translation of this article became available to Western scientists a year later under the title "Tracks of a Creeping Animal at the Bottom of the Pacific."

Today we still have only the trails as a clue, and there is no complete answer to the mystery of the trailmaker. Researchers still want to know what precisely is this deepwater animal that leaves its markings on the sea floor in a pattern so remindful of those fossilized tire treads in North American rocks of the Cambrian Period. Evidence of the new animal may not be found again for years but oceanography has become so competitive internationally that underwater cameras sooner or later will almost certainly produce photographs not only of more tracks but also, perhaps, of the trailmaker itself.

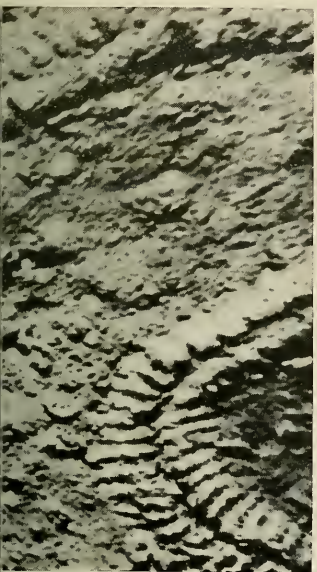
Meanwhile, the clue has produced fruitful discussion. A starting point is that the imprints (seen in the photograph on this page) are genuine enough, but as *Pravda* pointed out, the animal that made them is "so far unknown to scientists." In

their technical article, Vyalov and Zenkevich compared their find with known trails. They recalled that some British photographs from the Atlantic, made at almost twice the depth of the Russian discovery, show unidentified trails of about the same size and general pattern but "not quite clear enough for a detailed analysis."

However, the situation need not be one of total gloom. Although the Pacific Ocean creature awaits positive identification, we do know that a half inches wide. In each case it is apparent that the creature had transverse segments, which account for the crosswise tread marks it left behind; and that these imprints were bisected by some appendage capable of making a median furrow during locomotion—in all probability a tail portion dragged through the crosswise imprint made by the forward part of the body.

2. Partial similarity in habitat. The ancient trails were found in Potsdam sandstone formed in the described the North American trails in considerable detail, he proposed the generic name *Climactichnites*, which means "rock with ladder-like footsteps." This aptly describes a sediment whose markings bear a superficial resemblance to the tire tracks of a modern automobile. However, they are not "roll" marks, but "skip" marks. They show that the lower parts of the animal were probably raised off its sandy beach between points of contact.

A large specimen of rock with



A living creature left these "tire tread" tracks on the muddy bottom of the western Pacific, between the Caroline Islands and the Solomons. But what kind of animal made the curving trail? One guess comes from fossilized clues found in North American rock 8,500 miles away and a half billion years old. This clear photo of the Pacific trail was taken at a depth of nearly 10,000 feet by an underwater camera from the Russian research ship Vityaz. *In the Atlantic Ocean other oceanographers have recorded unidentified trails of about the same size and general pattern—although not so clear—at almost twice the depth.*

its tracks closely resemble the clear imprints preserved in North American rock. Hence the intriguing possibility that the animals responsible for each set of trails may have had a common ancestry, and despite the great difference in distance and in time, it is possible that these animals are related taxonomically. Technically speaking, here are two reasons why this possibility is worth examining.

1. Similarity in size and shape. The trails from the Pacific are about four inches wide. Those from the North American rocks are not far from that—between five and six and Late Cambrian. At that time the region's environment included a shallow inland sea and its sandy beach zone; in this zone the trails were formed and preserved. The new trails come from a generally similar environment, though with much deeper water, where they were associated with a rather soft globigerina ooze or sand, evidenced by bottom samples the *Vityaz* dredged up.

But there are enough other factors to quickly convert any neat comparison into a mystery with many pros and cons. Let us examine them.

In 1852, when Sir William Logan such imprints, from Clinton County, New York, is now in the New York State Museum at Albany. The site consisted of typical Late Cambrian sandstone dating back to a half billion years ago. (Every year thousands of visitors see such well-bedded sandstone of Potsdam age at Ausable Chasm on the northeast edge of the Adirondacks.) Comparable rock structures occur in several states westward to Minnesota, and crop out extensively in eastern Canada along the border of the Canadian Shield, but here they are Early Ordovician, which followed the Cambrian. The

different age of Potsdam deposits in different places, as indicated by the fossil record, is explained by slow northward transgression of the shallow sea and its sandy beach zone, where the *Climactichnites* trails were formed.

Professor J. B. Woodworth of Harvard attempted in 1902 to duplicate these imprints by maneuvering wooden blocks, shaped like the animal's supposed segments, across a surface of wet sand. Similar experiments were recently made in New Zealand by E. Z. Arlidge. His purpose was to discover whether certain peculiar markings in rocks could be formed by inorganic processes, as well as by living creatures. For example, radial and concentric patterns resembling organic remains can be produced in wet natural clays subjected to the action of a vortex. On the other hand, without careful examination some bioglyphs (organic structures) can be mistaken for marks left by water currents. A recent paper by two geologists, Stanislaw Dzulynski and J. E. Sanders, has clarified this as far as firm mud bottoms are concerned.

These various experiments indicate that the Potsdam markings were the result of organic rather than inorganic phenomena. But it is not certain whether they were caused by giant trilobites, burrowing crustaceans, or other arthropods; by creeping holothurians (sea cucumbers), browsing snails, or segmented annelid worms; or even by plants of some kind. However, Donald W. Fisher, New York's State Paleontologist, regards *Climactichnites* as an arthropod trail. He points out some similarity to the trail made by a particular arthropod. *Limulus*, the horseshoe crab, which has persisted practically unchanged at least since Devonian time began 400 million years ago and possibly longer. Its zoological affinities remain in doubt, but it is generally placed in a class or subclass of its own, the Xiphosura. Although tolerating a wide range of salinity and temperature, today's North American horseshoe crab lives in shallow water and comes to the beaches at spawning time. In this respect, of course, it differs from the deepwater animal that made the trails in the Pacific. But this does not eliminate possibilities that the Pacific creature is an arthropod. A number of other still-extant arthropods, notably the Decapoda, likewise reach a considerable size, and some live in deep water.

Another possibility, of course, is that the Pacific animal is related to the giant trilobites—a group of marine arthropods that are now extinct. But Dr. Fisher points out that, although trilobites large enough to produce trails of the required size did exist during the Cambrian, no fossils of such animals have yet been reported from the Potsdam sandstone that revealed the imprints. Consequently, he agrees that the riddle of the *Climactichnites* trails remains unsolved.

Thus we know nothing definite about the habits of either the modern creature from the Pacific Ocean or its Potsdam counterpart. There is only the evidence provided by their remarkably similar trails. And this evidence must be weighed carefully. The actual markings made by an animal necessarily depend on whether it was crawling, running, burrowing, or swimming, as well as on the condition of the sediment—obviously, tracks and tunnels may have been made by the same animal.

In the case of the Potsdam *Climactichnites* one end of the trail sometimes has an oval impression as wide as the trail itself. Possibly this was made by a reproductive organ; more likely it represents the shape of the animal at rest, before it started to move. The Pacific photograph shows nothing similar; but then, it does not include the beginning or end of the trail.

If the similarity of the trails should not be exaggerated, neither should their importance be minimized. The relationship between an animal's trail and the activity that produced it has been neatly expressed by the paleontologist James R. Beerbower, who wrote: "A reptile crosses the moist sand of a beach, and the shape of his foot, the tensions of his muscles, the compulsions of his brain, are imprisoned forever." This statement would apply especially to the seven-foot-wide tracks left in soft sand by the giant leatherback turtle, a Malayan species. But it also refers to small creatures like the coyote, fox, and woodchuck, and on up to the elephant, lion, and rhinoceros. The same applies to birds, bottom-hugging fish, and—as in this case—to invertebrates.

Here we have two trails with notable similarities of form, although far apart both in time and place. That the North American trails are found in consolidated sandstone, whereas the Pacific trails are in globigerina ooze may be of no great

significance. Giving the name *Climactichnites* to both types of trail merely describes the product of an organic mechanism; here generic and specific names lack their usual biologic significance. Vyalov and Zenkevich themselves point out that their new trail does not fit any natural classification, because the animal responsible is not known. Hence their special, new name—their trail is called *Mystichnis pacificus*.

The idea of an evolutionary link between the ancient and modern climactichnitid forms is not without

precedent. For example, living coelacanth fish have been found off the west coast of South Africa, although the species was thought to have become extinct at the close of the Cretaceous era, some seventy million years ago. The fact that they still exist was discovered in 1938, and additional specimens have been landed since then. Also, a living representative of the somasteroids (sea stars), previously thought to have died out about 450 million years ago in the Ordovician, was recently found. Long-span connections in such cases, as well as in the genus producing the climactichnitid trails, are made more plausible by the relatively slow rate of evolution in marine animals.

What is the record concerning such animal trails between the Cambrian and the present, and are any similar ones known from rocks younger than Cambrian? While *Climactichnites* appears to be the earliest and is perhaps the best-known, there are others of the same general shape although they differ in detail. The five-inch-wide *Climactichnites* is very large compared with these others, most of which are about a half inch across. Many have chevron markings and some have median grooves, but the Cambrian *Climactichnites* bears the closest resemblance to the Pacific discovery.

It is this resemblance that may mean the line of animals concerned has continued practically unchanged in the ocean depths ever since the Cambrian, and still lives in the depths of modern oceans. Alternatively, descendants of the deep-water Cambrian trailmakers may have become smaller than their ancestors and then, by further evolution, returned to nearly their original size. Whatever the precise linkage, several new animal trails have been added to the record in late years, especially from southern latitudes. Among them are well-defined trails from the Tumblagooda sandstone of Western Australia. These last are attributed to *Protichnites*, probably a close relative of *Climactichnites*.

Is there an ancestral kinship between the living Pacific animal and the species that left these tracks preserved in Potsdam sandstone a half billion years old? This photo was made in northern New York; but in the Cambrian Period the region included an inland sea, indicating that a marine creature made the ancient trails. Named Climactichnites *("rock with ladder-like footsteps"), they are five inches wide and similar to the Pacific find in pattern. In both cases, transverse segments would account for the "tread" marks; both also show a furrow, probably made by a dragging tail portion.*

A final question about the Pacific trailmaker cannot be ignored. Can such an animal exist at a depth of nearly 10,000 feet, where the water pressure is considerable? Although the ability of marine animals to exist at great pressures is difficult to explain, the fact is that some do, relying for nourishment on vegetable plankton. Each species, of course, has its own pressure-temperature tolerance, and there have been many recent studies on the ability of bacteria and various other biological systems to withstand the effects of high pressure and low temperature. There are records of life at truly surprising depths—for example, nearly five miles below the surface of the Atlantic Ocean. Moreover, there has been some revision of the traditional belief that water pressure at enormous depths is the most important influence determining the physical characteristics of deep-sea life. At a recent conference in Miami, Gilbert L. Voss, an expert on cephalopods and the like, reported that more importance should be attached to the low temperatures and sparse food supply at such depths.

One of the suggestions about the Pacific animal—its possible relationship with the modern horseshoe crab—is therefore worth noting again. Certainly conditions along the shoreline, where this type of *Limulus* lives, are very different from those in the deep ocean. But since water depth is evidently not an absolutely critical factor, the possibility is not ruled out that the trails in shallow-water Potsdam rocks and those on the Pacific floor were both produced by animals at least related in some way to *Limulus*.

This underlines the fact that any conjectures made so far about the Pacific animal cannot be confirmed until the creature itself and the trails it makes are seen at the same time, in the same place. Such a prospect is not impossible. For instance, there was the old question about what made some spiral-shaped patterns on the sea floor. Then in 1965, zoologist Donald W. Bourne and geologist Bruce C. Heezen reported the answer—in the form of photographs showing the animal responsible. It was a "giant" enteropneust, or sea worm, and it was resting beside what was clearly its own trail.

The Slash-and-Burn Technique

Swidden farming follows a rotation pattern in which woodlands supply ashes that enrich the soil ahead of food crops; it is still practiced by millions of agriculturists in regions on both sides of the Equator

Smoke rises as *Hanunóo's newly set fire begins converting woodland slash to soil-enriching ashes.*

by W. M. S. Russell

From the layers of plant pollen found buried in Danish and Irish bogs we know the kinds of vegetation that grew there during successive periods of time. An examination of the deposits also tells the story of a simple farming method that reached Europe about 5000 B.C., and that still persists in various parts of the world.

Before the Europeans could begin raising crops, something had to be done about the great forests. They did it by slashing and burning the trees. Evidence of the burning shows in the pollen record as a layer of oak charcoal. On the cleared plot the ancient agriculturists then grew wheat and barley for anywhere from ten to twenty-five years, until the declining yield showed that the soil was exhausted. Whereupon they moved on to open up a new area in similar fashion, leaving the old clearing to become overgrown by brush, and then trees. Years later, others might again clear the same plot by the slash-and-burn method, thus beginning a new cycle.

This kind of shifting cultivation was a natural one for simple farmers in their first encounter with tree-covered land. A similarly mobile type of agriculture appeared nearly 7,000 years later when the first European corn-growing pioneers plunged into the temperate-zone forests of North America. Eventually, of course, the growth of settlements and increase of population made it necessary to clear the forest permanently for the continuous use of the same patches of land. In Europe the requirements of this settled type of agriculture were gradually met by an increasingly elaborate balance of mixed farming, with crop rotations and animal manure serving to keep the soil fertile. In North America's forest belt, such permanent settlement developed much faster, and not without disastrous impoverishment of some of the land. At any rate, on both continents today a choice is made: The old temperate-zone woodlands are either conserved, for their timber-growing potential or for recreation, or else they are permanently cleared, for a settled agriculture equipped with all the resources of modern technology.

Bamboo torch fires a swidden in the Philippines. The Hanunóo farmer moves along a protective path.

Only in the cold far north of Europe did temporary clearing linger on to any marked extent. One reason was that the oak forests there gave way to damp spruce and pine woods growing on poor, sandy soils. The trees were cut, the litter was burned to make a thick layer of mineral-rich ash, the ground was hoed (in later periods, plowed) between the tree stumps, and oats or rye (which tolerate the cold) were grown for a while; then the farmers moved elsewhere, leaving the deserted plot to birch and alder, and at last to the returning pines. This was the same method that had been used in the oak forests. It lasted into the late nineteenth century in northern Russia, until 1918 in northern Sweden, and persists today in parts of Finland.

For the Finns, the farm in the clearing must long have been a familiar sight; in their ancient national epic, *Kalevala*, the voice of the old hero Väinämöinen is said to stumble like the hoe among the pine roots. But certainly by A.D. 1781, and probably much earlier, some Finns had transformed the old, casually shifting cultivation into a regular rotation of forest farming. In the first year, they felled the trees. In the second, they burned them. For the next four to six years they grew crops among the stumps. For twenty to thirty years after that they allowed the clearing to revert to forest, then they returned to the same plot and same cycle. Such systematic rotation appeared in Sweden, too, probably brought by Finnish immigrants.

But this way of farming eventually declined, along with the older, casual procedure, as the demand for northern timber increased among peoples farther south and as modern methods made settled agriculture more productive even in the north.

Although forest farming is dying in temperate lands, it remains much alive in the rain forests and savanna woodlands that exist on either side

of the Equator, covering vast areas in Central and South America, Africa, Asia, and the islands of the Pacific. Such farming is not a curiosity for anthropologists, a quaint survival among a few backward tribes; it is the way of life for a substantial fraction of the human race. Figures for 1957 estimate that farming on temporary clearings was practiced by over 200 million people (nearly 1 in 12 of the world population), on 14 million square miles (about 30 per cent of the world's cultivable land).

A few isolated tribes with rather simple cultures, for instance in the Amazon Basin and on the uplands of Burma and Thailand, practice the haphazard shifting cultivation of the pioneers. But most forest farmers long ago adopted systematic land use. The area under crops shifts its position, but any given plot is regularly rotated between cropping and fallow. In the fallow period the forest returns, hence this system is sometimes called forest fallow rotation.

Systematic slash-and-burn agriculture has evolved independently in all tropic regions. The farming system and the cleared plot are usually known by the same name, but this varies with locality, so the same practice is called by many names. From Central and South America we have milpa, coamile, ichali, conuco, roça; from Africa, masole, chitemene, tavy; and from the Far East, chena, djum, bewar, dippa, erka, jara, kumari, podu, prenda, dahi, parka, taungya, tamrai, rây, hwajon, djuma, humah, tagal, ladang, kaingin. English-speaking scientists have coined several additional terms, including slash-and-burn, fire agriculture, and forest fallow rotation; they now generally call the typical plots in all these places swiddens (from an old English country word for burned clearings), and the system is swidden farming.

The basic practice is similar all over the tropics. A swidden site is carefully selected. Trees are either felled, usually leaving the stumps, or completely stripped of their branches; creepers and underbrush are slashed away; and the resulting litter, or slash, is spread over the swidden. This is done in the dry season, so the debris soon dries out. It

Polite detour-marker warns traveler to avoid foot-tangling slash in a freshly cut Hanunóo swidden.

is then set on fire (sometimes with precautions to prevent the fire spreading). This leaves the swidden covered with a layer of ash, ready for planting crops in time to take advantage of the coming rains.

In Europe, and even more so in North America, a farm field conveys the idea of rows and rows of crop plants all of the same kind. By contrast, a swidden is generally like a North American vegetable garden run wild, covered with all sorts of crop plants that will be harvested at different times. In a typical Central American swidden, for instance, squash vines spread over the ground surface, cornstalks rise into the air, beans climb up the cornstalks. The most sophisticated swidden farmers known are the Hanunóo on Mindoro Island in the Philippines, who are impressive botanists. About 1,200 plant species are known in their region, but the Hanunóo themselves distinguish 1,600 different kinds—evidently their classification goes down to plant varieties. Of this number, they actually breed more than 400 kinds in their swiddens. Various other species reproduce themselves. To protect these when the swidden is burned, the farmers wrap them in green plant material.

Generally, among such peoples the swidden is cultivated intensively for a year or so, then gradually less intensively, and finally abandoned. For instance, in Ondo Province, Nigeria, one practice is to clear the swidden in February and burn soon after. Yams and corn are planted with the first rains, together with pumpkins, melons, and calabashes. When the farmers harvest the first corn, in June, they plant beans, manioc, okra, and cocoyams. In September-October they harvest the yams; in October-November they harvest a second crop of corn, which was planted in August. A third corn crop may be planted in the next rainy season, and the farmers may return for a year or two thereafter to dig the manioc and cocoyams, but they generally do not immediately plant this plot again.

Fruit trees are often included among swidden crops, and their fruit may be harvested for several years after the swidden is abandoned. Meanwhile, through regeneration from stumps (which are left three feet high in Nigeria for this purpose) and by growth of seeds from the surrounding bush, the swidden gradually reverts to forest. It will not be cleared again for some time. In the interval, other swidden sites are cleared and go through the same cycle.

The periods under intensive cropping and under fallow vary in different places, but when the system is working effectively the cropping period is always relatively short, and the fallow period relatively long, as seen in the chart below.

REGION	YEARS UNDER INTENSIVE CROPPING	YEARS UNDER FALLOW
Philippines (Hanunóo)	2–4	8–10
New Guinea	1	15–20
Ceylon	1–3	8–20
Sierra Leone	2	12–15
Ghana	1–3	10–15
Nigeria (rain forest)	1–2	8–14
Nigeria (savanna woodland)	4	Up to 30

The method of selecting new swidden sites has been studied in detail among the Hanunoo. These people choose sites where the composition of the fallow vegetation has reached

the stage ready for slash-and-burn. This may be from eight to ten years after the previous cropping period. The expert Hanunóo do not work with map and calendar. They are guided by botanical criteria that are flexible and highly relevant for their purpose. This method allows for local differences (between soils for instance) and ensures that the fallow period has lasted long enough.

In some parts of the tropics, specially modified forms of swidden farming are practiced, such as the system characteristic of Zambia but found in many other woodland areas of East Africa. In this chitemene system, the farmers slash and burn not only the trees and underbrush of the swidden; they add branches brought in from the surrounding woods. In Sudan, several tribes omit burning the swidden, and instead take advantage of the fact that termites quickly reduce the woody litter to powder. Also in this region are the Dinka, who practice a kind of termite-chitemene system—they collect wood from some distance and pile it in the swidden for the termites.

Not all swidden farmers are people with extremely simple cultures. The Hanunóo, for instance, can write, so they post notices warning neighbors to avoid walking into a clearing that has been slashed but not yet burned. However, the actual farming method is basic to the way of life of all these peoples. It is also encumbered with considerable ritual. To early European observers, the whole procedure seemed senseless, primitive, and a gross waste of land.

Yet there is often method, even in the rituals. The Hanunóo drive a hollow bamboo stick into the ground at a possible swidden site. If the soil does not rise high enough inside the stick, they discard the site and clear elsewhere. Although they regard this as a purely magical test, it can be a crude agronomic way of appraising the soil's structural readiness for tillage. And on many points, these and other swidden farmers can often give excellent scientific reasons for their practices.

Many Europeans must have had the experience that Bishop Mackenzie described to fellow missionary and explorer Dr. David Livingstone in the mid-nineteenth century. "When telling the people in England what were my objects in going out to Africa," said the Bishop, "I stated that, among other things, I meant to teach these people agriculture: but I now see that they know far more about it than I do."

Furthermore, the swidden system is extraordinarily suitable for the tropical environment. Considerable experimental work in Africa, for example, indicates how the system conserves soil fertility. To begin with, the heavy rains keep many tropical forest and woodland soils poor in nitrogen, phosphorus, and other mineral elements that plants need. Nitrogen is normally present in soils either in an insoluble form unusable to plants, in organic matter, or in soluble forms (chiefly nitrates) that plants can take up. Every year, in the tropical rainy season, much of the nitrogen in organic matter is converted by soil bacteria into nitrate. Some of this is used by the plants, but much, being soluble in the rain water, is washed out of the topsoil. This means the stock of available nitrogen is steadily diminished. Phosphorus and other mineral nutrients are also leached down beyond reach of the plant roots.

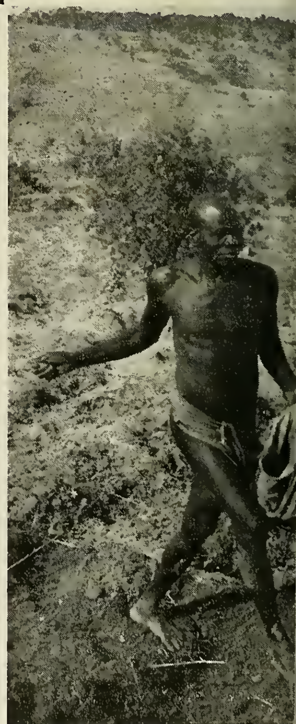
This leaching problem often also affects the damp, sandy pinewoods of northern Europe, and the benefits

With his bolo this Hanunóo weeds a combination crop: maize, rice, cassava, pigeon peas, banana plants.

Left: Nigerian farmers hiking hon from swidden on which acha, a low-grade form of millet, is raise

Right: beer will reward th Nigerian volunteers racing to new furrows for a peanut cr

Below: sowing acha seed. This cereal grows where others do not; natives call it "hungry rice."



of forest fallow have been experimentally demonstrated in Finland as well as in Africa. When leached soils are continuously cropped without manuring, the available nutrient elements are soon used up; crop yields fall and eventually fail. This had begun to happen by 1933, for instance, in parts of Zambia where continuous cash crops of corn had replaced the chitemene system.

Forest fallow restores fertility in at least two ways. First, it constantly returns plant material to the soil as litter (leaves, dead branches, and so forth); then soil bacteria, stimulated by the tropical warmth, quickly convert the litter to organic matter, where the nitrogen content is safe from leaching. Thus the reserves of soil nitrogen gradually increase. Secondly, deep tree roots bring back phosphorus and other mineral nutrients that were leached down to lower depths, and concentrate them at the soil surface or in plant growth—"living fallow." If the fallow is allowed to remain long enough, the topsoil is much enriched in organic matter and mineral nutrients by the next time the plot is cleared.

Early European visitors supposed that burning the slash must be harmful. But agronomists have shown the reverse to be true. The phosphorus and other minerals stored in growing trees are all deposited in the ash, which makes an excellent fertilizer (especially when the forest outside the swidden is also exploited, as in the chitemene system). Although nitrogen in the growing trees is lost to the atmosphere when they are burned, very little of the new store of organic matter in the soil is destroyed by the fire. Experiments in Malawi, Sierra Leone, and Zambia have shown that the burning is in itself beneficial, for burning slash on the swidden gives a higher crop yield than burning it elsewhere and bringing the ash to the swidden. Experiments in Brazil suggest that burning affects soil bacteria (by killing some and stimulating others) in just the right way to improve the soil nitrogen cycle. It is because of this that the crops on a swidden grow and yield well for a few years—until the rebuilt stores of nutrients are exhausted.

Swidden farming can offer other benefits in the tropics. A frequent

problem, for example, is actual destruction of the soil by erosion resulting from heavy tropical rains. Where soil is unprotected by fallow, the raindrops may break up part of the surface, and batter the rest to form a waterproof cap. Then the rain water, instead of soaking into the soil, runs down slopes. This runoff may finally tear away the soil in sheets or gouge it into deep gullies.

On steep slopes, one elaborate answer to this problem is building terraces to check the force of the runoff and allow time for water and silt to accumulate on the terrace steps where the crops are grown. Terrace building is laborious, however, and not usually done on a plot used for only a few years at a time.

The swidden system is easier and has many built-in safeguards against soil erosion. When choosing a site for clearing, the Hanunóo carefully avoid uneven ground and unstable soils vulnerable to erosion; for this they use their elaborate classification of soils, which agrees well with results of scientific soil analysis. Then, during the critical period when the newly cleared swidden is exposed to the danger of wind erosion, the drying slash is spread over every square foot of soil as a dead cover, or mulch. (Hanunóo teen-agers who find this chore a nuisance are lectured by their elders about soil erosion.) Creeping, erect, and climbing plants protect the soil during cropping. Afterward the new covering of forest fallow takes over: the foliage and litter break the rain's force, so that it sinks gradually into the soil.

But there is another tropical hazard—the rank growth of weeds, including grasses. Within a year or two after it is cleared, the swidden may become choked by these light-loving plants. Indeed, this often is why the swidden is abandoned so soon. If the forest fallow is able to regenerate, the shade of the trees will eventually suppress the weeds. A way to aid this process is to leave tree stumps and protect some trees during the fire, so they can provide shade for the tree seeds coming from outside the clearing. The stumps serve another purpose: new growth often sprouts directly from them.

By this method the swidden farmers give the forest a chance to return and compete successfully with the weeds. But if cropping goes on too long, the soil may become too poor for trees to get started, and grass weeds may get too much of a grip. The balance now tips in favor of grass against trees, and the plot becomes grassland.

In parts of Africa, swidden farming has become adapted for grassland fallow. But in tropical rotations the grasses are less satisfactory than trees. Their roots are too shallow to reach mineral nutrients leached into the lower soil. Furthermore, the grass supplies little litter for making organic matter. Grass fallow rotation generally supports only low-yielding, small-grained cereals like the millets, and only on the least-leached soils. Finally, tough, tall grasses like *Imperata cylindrica*, called cogon in the Far East, are liable to take over, turning the plot into a cogonal—an intractable sod that cannot be farmed (at least by ancient methods).

Proper swidden techniques, on the other hand, are admirably adapted to the tropical environment. But they accomplish their purpose only when

A Nigerian swidden after firs crop. The shelter and shade t are for resting migrant worke

Roughly carved out of Amaz jungle, this swidden grows its rice crop among the tree stump

the ratio of fallow period to cropping period remains high. This requires a great deal of land for each family. For example, if the cropping period is two years and the fallow period is eighteen years, then only 10 per cent of the land is under crops at one time. Hence the system will only support a very low population density—generally about 130 people per square mile, according to an estimate made in Java and widely accepted for the tropics as a whole. The system worked, therefore, during the thousands of years when tropical populations were kept low by parasites and infectious diseases.

But in the twentieth century, modern medicine caused a dramatic increase in populations all over the tropics. Inevitably, a greater proportion of the land was used to meet the need for more food. Also inevitably, the cropping period grew longer and the fallow period shorter. By 1964, for instance, the forest fallow period in parts of Sierra Leone had shortened drastically. It had lasted from twelve to fifteen years; it became three or four years. By 1955, it had shortened in Iboland (Nigeria, rain forest zone) from between eight and fourteen years to three or four years. On parts of the Jos Plateau (Nigeria, savanna woodland zone), a sequence of four years under crops and up to thirty years of woodland fallow became four to six years under crops and one to two years under grass fallow—the woodlands had disappeared.

With this changing ratio of cropping to woodland fallow, the fallow often ceased to fulfill its functions, and eventually was unable to regenerate at all. Crop yields steadily declined as the fallow period shortened. In Benue Province (Nigeria), this deterioration was already noticeable by 1927. Today, over large areas of land, forest has been replaced by cogon grass and has become useless for food production; such cogonals cover 18 per cent of all land in the Philippines. Over other large areas, especially in Africa, India, and Burma, soil has been altogether lost by erosion.

Thus, throughout the tropics, the swidden system is tending to break down under the weight of rising populations. This, of course, is only one aspect of the growing population crisis throughout the world. Between 1958 and 1964, world agricultural production was spectacularly increased by prodigies of technological effort; but production per head remained constant because of the swelling population. Even assum-

ing that the population problem will be solved, however, the swidden method faces reappraisal.

One answer may be to replace it with new farming methods. Although many swidden families have settled homes (however much they shift their plots in the surrounding forest), their way of life is difficult to integrate with that of modern civilization. And it will certainly be desirable to make vast areas of land more productive, capable of contributing more to mushrooming urban societies. To this end, intensive efforts are being made to find better forms of tropical farming. But even with all the resources of modern technology, the task is difficult and the problem far from solved (a tribute to the limited but real achievements of swidden farming, which were made without any of these resources).

In the drier parts of tropical regions, continuous cropping may well prove possible on a large scale. Experiments in savanna areas of Africa have shown that continuous cropping with compost, animal manure, or chemical fertilizers is far more productive than rotation with the grass fallows to which many such areas have been reduced. In surviving savanna woodlands, too, such methods may be better than swidden farming, although it is likely that the chemical fertilizers would have to include more nutrients than the conventional nitrogen, phosphorus, and potassium, which generally suffice for soils of temperate zone lands. The development of mixed farming (providing abundant animal manure) is perhaps the most hopeful solution. This would require introducing improved breeds of animals and (in Africa) eliminating the tsetse flies, harbingers of human and animal disease.

But in the heart of the rain forest there can be another answer. Much research is now directed toward developing a modernized swidden system. It would rely on a fallow made by deliberate planting of selected trees (or sometimes creeping plants), which will either restore soil fertility better and faster than natural fallows, or make possible a new combination of farming with forestry. So far, the attempts have shown little improvement over natural fallow, but research continues. It may well be that, in some such modernized form, man's oldest way of forest farming will continue to prove its worth.

REVIEWS *continued from page 25*

enon, as one of the better books. The classic, which is a "must," is the reissue, in paperback, of Captain Ruppelt's *Report on Unidentified Flying Objects*. Then there is Michel's *Flying Saucers and the Straight-Line Mystery*. The reader may not agree with the manner of presentation in these books, but he will gain some insight into the mysterious and controversial UFO phenomenon.

A good acquaintance with the subject is advisable before tackling the Sanderson book, *Uninvited Visitors*. It is not really a book for the beginner (yes, there can be beginners in the UFO field too!). Sanderson attempts to marshal and organize what is known today about UFO's, and he also asks such questions as: What might UFO's be? What forms do UFO's take? What about the reported occupants of UFO's? Where might they come from? Do they exhibit "intelligent" behavior?

He writes with skill; his book is certainly one of the more literate of the UFO books, albeit many will find it one of the "wilder" ones. Sanderson is not afraid to advance the thesis that, from a biologist's viewpoint, the UFO's may indeed be a form of animate matter. He supports his thesis by a logical array of facts that demonstrate that the reported behavior of UFO's exhibits many of the properties ordinarily ascribed to living things. If we have life forms in the dark depths of the ocean, and multifarious life forms on the surface, why not heretofore undiscovered animate matter in the upper reaches of the atmosphere? "And here once again," he writes, "we find ourselves confronted with the same old alternative—namely, that UAO's [he chooses UAO—Unexplained Aerial Objects—in preference to UFO] are either themselves life forms or they are constructed by life forms."

The thesis may shock the reader, but the arguments, based on a series of premises, are logically presented. The major premise is, of course, that the reported action, behavior, etc., of UFO's are really so. Like so many UFO authors, he assumes that the reader will accept, without vigorous documentation, that what was said to have occurred, did occur. And so we are back where we started: did even one true UFO actually happen? Sanderson, accepting the facts as reported, boldly takes the steps that seem necessary to explain the facts. Since sudden appearances and disappearances are frequently reported, Sanderson treads where fools, as well as angels, have feared to tread; he accepts what mystics have been telling us for many centuries—that there is more to the world than meets the eye. "And this brings us squarely and frontally,"

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Sanderson writes, "to the real pith of the whole UAO business—ITF, or instant transference." In short, teleportation and materialization. Unacceptable to almost all of us, but it does explain the reported facts.

Despite its daring approach, the seasoned UFO reader will rate the Sanderson book much higher than the Edwards book. The latter carries on the unfortunate reportorial tradition of "a story at any price," let the facts fall where they may. Truth is outraged throughout the book. In describing just one case, for instance (one I have personally investigated), I find Edwards is wrong about the number of photographs taken, about the make of the camera, about the location of the camera, about the name of the mountain, and about the object's maneuvers "over a fire tower." All minor points, perhaps, but what is unforgivable in the interest of truth is the statement that the person taking the picture was interrogated after taking truth serum (sodium pentathol) and came through with flying colors. According to his direct statement to me, the person was *not* questioned under the influence of the drug. But it makes a better story.

The literature of the UFO, in this and other countries, is assuming large proportions. The librarian, apparently, will face the UFO problem before the scientist does.

Dr. Hynek is Professor of Astronomy at Northwestern University and Scientific Consultant to the U.S. Air Force on the subject of UFO's.

HUMMINGBIRDS, by Walter Scheithauer. *Thomas Y. Crowell Company, $10.00; 176 pp., illus.*

Crawford Greenewalt's beautiful book on *Hummingbirds* (published in 1960) now has a rival. Walter Scheithauer is a German who has made a hobby of keeping hummingbirds in his aviary—he has had over a hundred individuals of some thirty species. He has maintained the birds with great success, even having them mate, build nests, and raise the young. His experiences—successes and failures—are recounted in his book, along with seventy-six magnificent color photographs of the birds in action.

Comparison with Greenewalt's book is inevitable. Each author, by dint of endless patience, complex apparatus, and great skill, has managed to get a remarkable series of hummingbird portraits. I find it impossible to decide whose photographs are the better; Greenewalt's book is a more lavish and elegant production, but it is also much more expensive. Both authors give

good summaries of what we know about the biology of hummingbirds, enhanced in Greenewalt's case by wide experience with the birds in the field, and in Scheithauer's, by intimate acquaintance with birds in his aviary.

Certainly anyone contemplating keeping hummingbirds in captivity should have Scheithauer's book, where his methods and observations are described in detail. The main problem is food, and Scheithauer gives not only his own formula but those used successfully by the major European zoos. These all differ in detail, but each provides a properly balanced diet. It is abundantly clear that hummingbirds can be kept in captivity easily—with daily attention—and that they seem perfectly happy in an enclosed space. They make ideal animals for a greenhouse because they do no damage to the plants, but carry on with their acrobatics, their fights, and their ridiculous "songs," quite indifferent to the presence of humans watching them with fascination. But Scheithauer's book should appeal to anyone interested in the behavior of these extraordinary birds.

MARSTON BATES
The University of Michigan

TREASURES OF PREHISTORIC ART, by André Leroi-Gourhan. *Harry N. Abrams, Inc., $40.00; 544 pp., illus.*

The publishers write that this book offers "a wealth of information, theory, and insight that greatly revises previous studies in prehistory." This is quite true. All future examinations of Stone Age culture will draw upon, and

Relief of woman holding bison horn.

refer back to, this book; it will have to be considered if only to take exception to any of its analyses and conclusions. It can well serve as a standard handbook to cave art.

It would be unfair, however, to stress only its high professional value, because even at $40 it is a handsome bargain for the non-specialized reader. He will find the text interesting and informative; the writing style lucid and informal and with a minimum of detailed technical elaboration, which he can scan without losing the continuity. The 121 color plates are uniformly excellent; the hundreds of black-and-white photographs and diagrams give a fine visual documentation of this amazing chapter in the history of art.

Using a punch-card cataloguing system, the author, director of the anthropological Museum of Man in Paris, brings a comprehensive statistical analysis to bear on this enigmatic area. He places the major portion of cave art between 17.000 and 12.000 B.C., and he sees it as the work of seminomadic people moving within a restricted hunting area. He finds no evidence of far-ranging movements of peoples, great invasions, or cataclysmic wars. Rather, the caves show a homogeneous and continuous art style with planned decorations. He takes exception to the usual techniques of reconstructing ancient society by analogies drawn from contemporary ethnographical groups, and of dating the cave paintings by means of looking for changes in style.

His methodology is logical and careful as he always attempts to proceed from the evidence, but sometimes he strays. For example, he tacitly assumes that ancient man distinguished between the religious and utilitarian, or that all art must be narrational. Yet such points are not faults but rather represent major areas of disagreement, which are to be expected in a field where the smallest bit of evidence must be made to bear a tremendous burden of interpretation. For, after all, we have some fragmentary remains from little more than 100 caves with which to reconstruct over 15,000 years of human history.

BERNARD GOLDMAN
Wayne State University

THE WILD GARDENER IN THE WILD LANDSCAPE, by Warren G. Kenfield. *Hafner Publishing Co., $7.50; 232 pp., illus.*

This is an unusual book—unusual in design, unusual in phraseology, and unusual in content. Also, it is unusually good. It contains accurate ecological information, practical directions for application of this information, attractive photographs of treated areas, and clear plans to suggest naturalistic designs. It is spiced by frequent rapier-like comments against indiscriminate herbicide spraying, half-truths perpetuated by commercial interests, and antiquated ecological concepts.

Essentially, this is a handbook for owners of suburban or rural acreages who do "not want to drown in an ocean of" brush, but hope, instead, to develop an easily maintained, naturalistic landscape. Largely, the author's approach is to eliminate unwanted plants and to let others, already present, grow. He labels this the art of "intaglio," from an engraving process.

Elimination of unwanted plants is to be accomplished chiefly with selectively applied herbicides, but cutting, pulling, mowing, and the use of mulches and grazing animals are mentioned. The use of fire is discouraged. The author has twenty-one years of experience with herbicides, and the book is crammed with useful instructions on formulations, methods of application, timing, and follow-ups. He also suggests that appropriate native and horticultural species can be introduced into

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4th ANNUAL
MAN AND NATURE LECTURES

Dr. Jerome Lettvin, Professor of Communications Physiology at M.I.T., will deliver 4 lectures on PERCEIVING in the auditorium of The American Museum of Natural History at 8:30 P.M. on the following evenings:

Monday, March 4
A Purpose for Color

Wednesday, March 6
The Hues of Colored Things

Monday, March 11
Monads

Wednesday, March 13
Who's I To Prospero: A Sketch of Calaban
Fixating Those Red Spots on The Wall That Ariel Sees

The public is invited to attend.

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the naturalistic landscape by seeding or planting. More than half of the text is devoted to "Naturalization Notes." Here the author lists many native and exotic herbaceous species, from ferns to ironweeds, and discusses their methods of propagation, flowers, and other features. Frequent comments on his own experiences with the plants make this section especially informative and occasionally amusing.

This is not a gardening book. It is certainly an innovative book on landscape architecture. And it is a provocative ecological essay. The author boasts no formal degree, but he unquestionably possesses experience superior to the bookish knowledge of many who do.

JACK McCORMICK
The Academy of Natural Sciences of Philadelphia

Briefly Noted

MONGOOSES, by H. E. Hinton and A. M. S. Dunn. *University of California Press, $6.50; 144 pp., illus.*

Everything, but everything, about the mongoose. The authors cover the

more obvious areas of reproduction, parental care, life-span, etc., down to their place in folk tales, their worship in Egypt, their diseases and parasites. The inclusion of every detail is often distracting: some species descend from trees head first, while other species prefer the rear-end approach; a four-day-old mongoose makes *kveer-kveer* sounds when hungry but *wurruck-wurruck* sounds when feeding. Anyone with less than a passionate interest in the subject will find this book rough going. C.B.

MAN AND NATURE IN THE NATIONAL PARKS, by F. Fraser Darling and Noel D. Eichhorn. *The Conservation Foundation, $1.50; 80 pp., illus.*

Based upon the authors' recent survey of the National Park System, this report by F. Fraser Darling (ecologist) and Noel D. Eichhorn (geographer) constitutes a well-documented and well-written recognition of the dangers facing the parks in the latter half of the twentieth century. While noting the sincerity of the National Park Service's intentions, the authors reflect the growing tide of opinion that future policy must be guided by extreme foresight, if the country's parks are to survive the pressures exerted upon them by our rapidly expanding and affluent society. J.H.

This list details the photographer or other source of illustrations, by page.

COVER—Fred Bruemmer
6—Arthur Swoger
14-15—AMNH
24—United Press International
27-30—Charles Pratt
32—top, Michael Nigro; bottom, Photo Researchers
33—Thomas Griffiths
34—AMNH after Thomas Griffiths
35—Thomas Griffiths
36—Photo Researchers
37—The Port of N.Y. Authority
39—Helmut Wimmer
40-45—Fred Bruemmer
47-50—Alan Ternes
52-53—Philip Jones Griffiths, Magnum Photos
54-57—O. C. Farquhar
58-61—Harold C. Conklin
62-64—Robert Netting
65—Unations
71—From Treasures of Prehistoric Art. Harry N. Abrams, Inc.

Suggested Additional Reading

NATURE AND THE CITY

THE PARK. J. Hope. *Natural History*, August-September, 1967.

THE MYTH OF THE MACHINE. L. Mumford. Harcourt, Brace & World, New York, 1967.

RECREATION NEEDS IN URBAN AREAS. R. C. Weaver. *National Parks Magazine*, December, 1967.

THE UNNATURAL HISTORY OF THE ANT LION

THE BOOK OF BEASTS. Translated by T. H. White. G. P. Putnam's Sons, New York, 1954.

AN IMPROBABLE SOLID

WALDEN. H. D. Thoreau. The Modern Library, Random House, New York, 1950.

THE MAGIC SURFACE. C. D. Niven, Pageant Press, Inc., New York, 1963.

ACROSS EARTH'S CRUCIAL BOUNDARY

THE CLIMATE NEAR THE GROUND. R. Geiger. Harvard University Press, Cambridge, 1965.

THE RESTLESS ATMOSPHERE. F. K. Hare. Hutchinson University Library, London, 1961.

ILL SHAPEN BEAST

POLAR ANIMALS. A. Pedersen. George C. Harrap, London, 1962.

THE MAMMALS OF KEEWATIN. F. H. Harper. Miscellaneous Publications 12. University of Kansas, Lawrence, 1956.

ETHIOPIA

THE LAND AND PEOPLE OF ETHIOPIA. E. M. Kaula. J. B. Lippincott Co., Philadelphia, 1965.

THE GEOGRAPHY OF MODERN AFRICA. W. A. Hance. Columbia University Press, New York, 1964.

ENIGMA ON THE SEA FLOOR

SEARCH FOR THE PAST. J. R. Beerbower. Prentice-Hall, Englewood Cliffs, 1960.

BURROWS AND SURFACE TRACES FROM LOWER CHALK OF SOUTHERN ENGLAND. W. J. Kennedy. British Museum (Natural History), *Geology Bulletin*, Vol. 15, No. 3, pp. 125-167, 1967.

THE SLASH-AND-BURN TECHNIQUE

HANUNÓO AGRICULTURE. H. C. Conklin. Food and Agriculture Organization, Rome, 1957.

THE PRE-INDUSTRIAL CULTIVATOR IN THE TROPICS. H. Popenoe. In THE ECOLOGY OF MAN IN THE TROPICAL ENVIRONMENT. International Union for the Conservation of Nature and Natural Resources, Publications New Series No. 4, Morges (Switzerland), 1964.

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In nature's infinite book of secrecy
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Shakespeare, *Antony and Cleopatra*

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The American Museum of Natural History

PATRICIA CAULFIELD, *Photography Columnist*
NATURAL HISTORY

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The New York Times

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2. No negatives should be submitted. Entries must be postmarked no later than March 15, 1968. IMPORTANT: No more than two pictures may be submitted by any one entrant.

3. Color photographs:
   a. Color pictures may be submitted as either a transparency or a print. Do not submit both a transparency and print of the same picture.
   b. Transparencies must be originals and must be mounted in cardboard only.

4. All prints (color and black and white) must be approximately 8x10 and unmounted.

5. General:
   a. On the back of the photograph or on the transparency mount *must* appear: name and address of photographer, make of camera used in taking the picture, and the place it was shot.
   b. Developing and printing may be done by a photofinisher or by the entrant. No composite picture, such as multiple printing, multiple exposure, or montage, is eligible. No artwork or retouching on prints or negatives is permitted.
   c. All color transparencies will be returned to entrant only if accompanied by a self-addressed envelope of proper size, bearing sufficient return postage. Black-and-white prints will *not* be returned.

6. NATURAL HISTORY assumes no responsibility for prints or transparencies.

7. Pictures will be judged on photographic quality and originality in treatment of the theme. The decision of the judges will be final.

8. Before receiving a final prize, the entrant must sign a statement that his picture, or any closely similar picture of his of the same subject or situation, has not been, and will not be, offered for publication in any manner prior to July 1, 1968. NATURAL HISTORY retains first publication rights to winning pictures.

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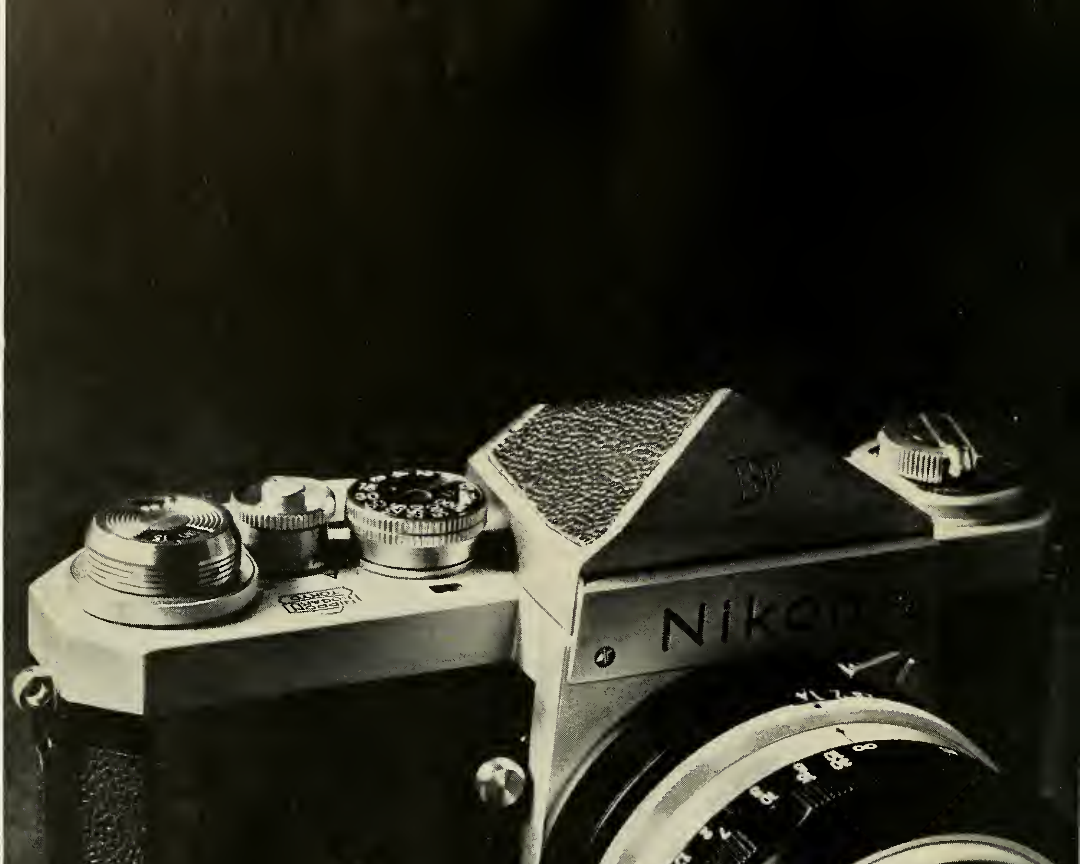
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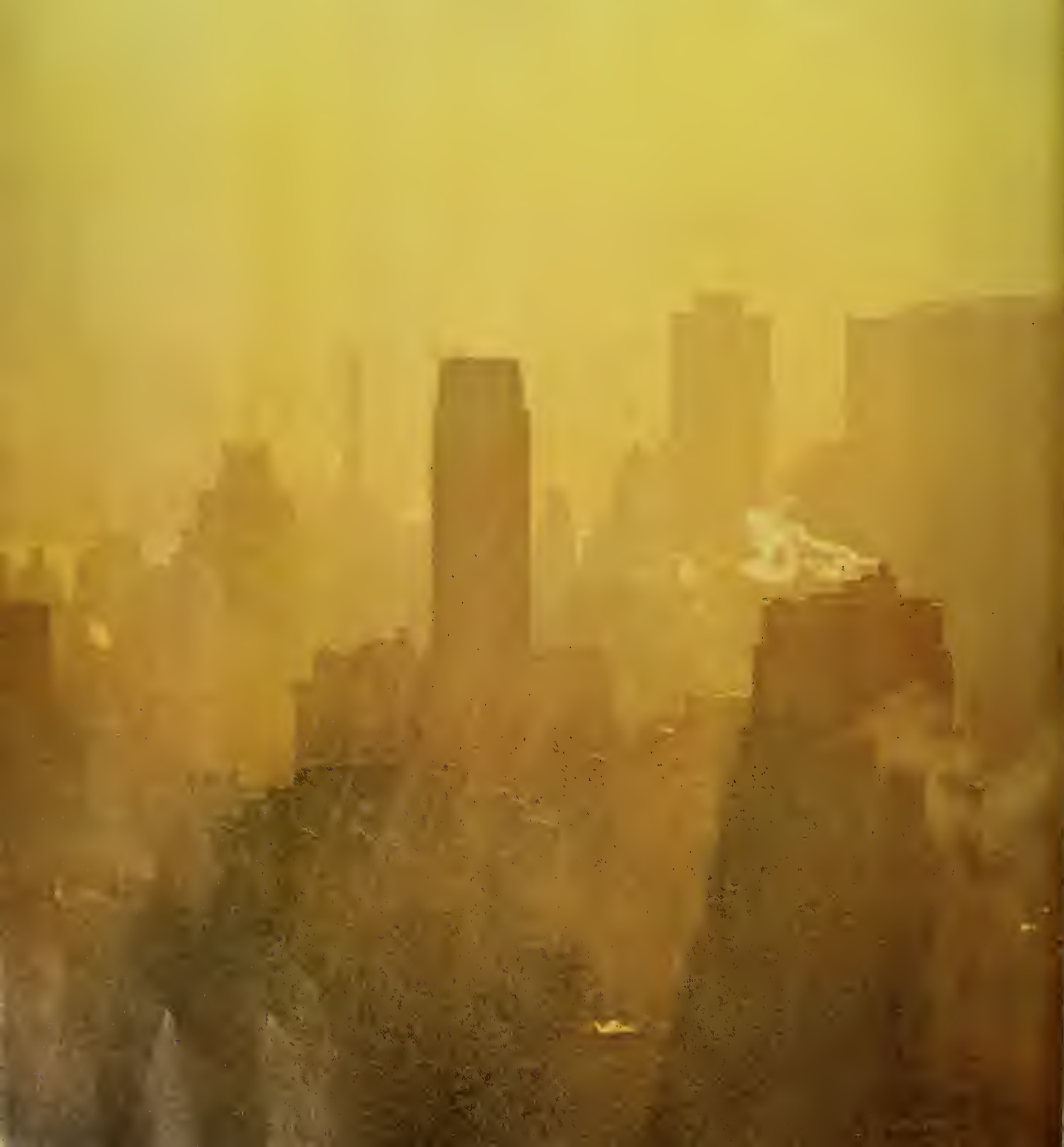

Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. LXXVII No. 4 April 1968

DEPARTMENTS

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Gerald Carson

Paul Byers

Bernard Vonnegut

Napoleon Chagnon

Demorest Davenport

William A. Calder

C. A. Spinage

THE AUTHORS

GERALD CARSON's article, "Kindness and Cruelty in Great Britain," in the December, 1967, issue of NATURAL HISTORY, drew such response that we asked him for this month's contribution, which takes a different approach to the beast and man relationship. Carson writes at his 150-acre home near Millerton, New York, where, he reports, he lives "in association with many other mammals who are welcome, and visiting members of the National Rifle Association who are not."

Most of PAUL BYERS' working life has been devoted to the communications field. He became a newspaper reporter after dropping out of the University of Chicago before World War II. During the war he was a cryptanalyst and later took a job as a magazine writer in Australia where he first purchased a camera. He became interested not so much in photographic techniques as in the problem of what a photograph is. Mr. Byers is now Lecturer in Photography at Columbia University's School of the Arts, and will leave for Africa at the end of this summer to study problems of communication in Kenya schools.

This month's article on tornadoes was contributed by BERNARD VONNEGUT, who wrote "When Will We Change the Weather?" for NATURAL HISTORY last December. He received his Ph.D. in physical chemistry from M.I.T. and is Professor and Senior Research Scientist at the State University of New York at Albany. In his article, Dr. Vonnegut, who developed the silver iodide cloud-seeding technique, offers a genuine opportunity to the layman when he asks for information; eyewitness accounts, it appears, may help solve the riddle of what causes tornadoes.

Grants from the National Institute of Mental Health allowed NAPOLEON CHAGNON to participate in a joint effort in biological research by the Instituto Venezolano de Investigaciones Científicas and the University of Michigan Medical School. He has reported on his studies among the Yanomamö, a primitive horticultural tribe of the Brazilian-Venezuelan border, in two previous articles (January and December, 1967) in NAT URAL HISTORY. Dr. Chagnon, wh now teaches anthropology at th Medical School at Michigan, re turned early this year to Yanomam country to continue his studies.

Since DEMOREST DAVENPOR finished his doctorate at Harvard i 1937 he has, in his words, "dabble in the study of the behavior of man types of animals in the marine lab of Europe and the United States. His primary interest has been th symbiotic relationships betwee plants and their pollinators. Dr. Dav enport's penchant for symbiosis i wholly equalled by that for relax tion; his photograph on this page i undoubtedly a record of one of th peripheral rewards of field work.

The photographs, save two, th illustrate Davenport's article we taken by DR. IRENE H. STUCKE Professor at the University of Rho Island, who introduced Dr. Dave port to the orchids of New Englan Dr. Stuckey is author of *Rhode I land Wildflowers*, published in 196 by the University of Tennessee Pres

WILLIAM A. CALDER's studies the roadrunner in the Duke Unive sity laboratory of Dr. Knut Schmid Nielsen, a well-known authority the field of desert physiology, we made possible by a three-year gra from the National Science Found tion. Dr. Calder received his Ph. in zoology from Duke University 1966 and is currently studying r piration and circulation in birds.

C. A. SPINAGE was born and ed cated in England. At the age of tw ty he left for Africa to join the Ken Police. His patrol work there quired that he master the use photography. Surrounded by the ri wildlife of Kenya, Spinage beca increasingly interested in natural h tory and, four years after joining t police, transferred to an agricultu and forestry institution where could more easily study wildlife. 1960 he read for an Honours Deg at London University. Presently l ing in East Africa he is author of t 1963 Houghton Mifflin book *Anim of East Africa* and of a book leased last month from the same pu lisher, *The Book of the Giraffe.*

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Bugs and Beast

From the Middle Ages to the Present Century, the Curious Legal Concept

A repentant sow hears a verdict of guilty in Lavegny, France, for killing a child. Her piglets, because of age, were acqu

efore the Law

east Trial Has Been Applied with Some Extraordinary Results

by Gerald Carson

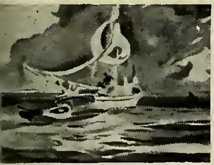
A peculiar feature of the jurisprudence of medieval times was the establishment of legal compacts between men and animals. Bugs, birds, small mammals, and the larger quadrupeds were supposed to live according to the law and to be familiar with the statutes. It was a kind of backhanded acknowledgment, perhaps, that animals had a place of some sort in the society of men. A surprising amount of litigation occurred in this curious field, especially in France, and brought much misery to the unfortunate victims whom the bailiffs caught *in flagrante delicto*. One modern investigator, pursuing this aberration of the scholastic mind, has devoted a whole book to the subject. The author lists 196 instances of beast prosecution, undoubtedly one of the most extraordinary expressions of anthropocentric thought that one may find in all social history.

It requires considerable imagination for an educated person living in the culture of the twentieth century to understand the involute thought of the medieval mind and the high seriousness of our ancestors in arraigning cabbageworms, he-goats and, indeed, all animals, domestic and wild, in courts of justice, where they were tried for homicide, mayhem, assault, felonies, misdemeanors, malicious mischief, or trespasses against the human community. One has to start with these premises: that the biblical account of the creation and the fall of man is literally true; that the earth and everything on it exists for man's use and enjoyment; that natural science, in the form of the Ptolemaic astronomy, confirms this, since the earth is the center of the universe; that the world is the setting for a Miltonic struggle between the forces of good and evil for the salvation or eternal damnation of mankind.

The beasts were caught up in this struggle, in relationships to man that could be on occasion affectionate, symbolic, or bloody. In this grand spectacle of moral warfare, the priests and the saints were ranged against hosts of demons, wizards, and necromancers who sometimes were believed to enter the bodies of the lower animals in order to work mischief through them. The miracle literature of the church cites numerous instances of devils appearing in the guise of blackbirds, mules, horses, bulls, pigs, dogs, rooks, worms, lions, and tigers. Sometimes animals demonstrated that they knew how to take evasive action. St. Regulus, bishop of Arles and Senlis, once cast a devil out of the body of a man, and the fiend tried to enter an ass. But the sagacious beast made the sign of the cross on the ground with his forefoot and repelled the invader.

Believers in sorcery and familiar spirits were not confined to the lower orders of society. Several popes; Montesquieu, famous author of *The Spirit of Laws* (1748) and a member of the French Academy; King James I of England; all accepted the reality of wizards and the black arts, while Joseph Glanvill, a man of scientific reputation and a founding Fellow of the Royal Society, wrote a treatise upholding the existence of supernatural power exercised by persons in league with evil spirits.

On the happier side, zoophilists could take comfort in the legends told of beasts demonstrating a touching confidence in the saints, and a



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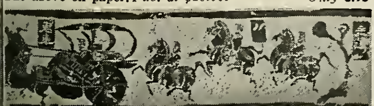

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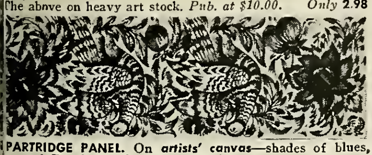

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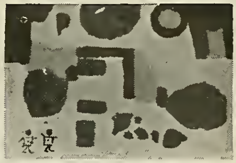

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long list of animals are reported by the hagiographers and homilists as having done men many a good turn, especially in feeding hermits who were out of provisions. One of the more striking instances of such acts of animal benevolence, regarding St. Stephen, third abbot of Citeaux, was related by the Bollandists in the *Acta sanctorum*. Once when the holy man was very ill, a bird brought him a fish. And what is more remarkable, the fish was already cooked.

The right to try, judge, and sentence dumb animals for injuries done to humans traces back to Mosaic law: "If an ox gore a man or a woman, that they die; then the ox shall surely be stoned, and his flesh shall not be eaten; but the owner of the ox *shall* be quit." Papers were served on the offending animal by an officer of the court who read them in a loud voice at places where the culprits were known to congregate. These documents were filled out with all technical formality, including a description of the said animals. Thus, if the proceeding was against rats, the defendants were described as dirty, grayish rodents who lived in holes. After the accused had been cited three times, judgment could be entered against them by default if they remained obdurate.

When the case went to trial an advocate was appointed for the defense, and the defendants were required to show cause why they should not be summoned. If no satisfactory excuse was forthcoming, they were then cited to appear. If they failed to do so, they were warned to leave the district, or they could be consigned to damnation by the dread curse of the church. This power was not one to be invoked lightly. Once when St. Bernard, in a moment of annoyance, said to a bluebottle fly that was buzzing around his ears, "Be thou excommunicated," all the flies in a whole province fell dead.

If the animals persisted in being obstinate, their contumacy was not attributed to any lack of competence on the part of the court but to the superior power, temporarily, of the devil and his minions. Sometimes vermin were generously forewarned of their peril. In the year 1545 the winegrowers of St. Julien, a commune west of Bordeaux whose growths still appear on good wine lists, complained to Francois Bonnivard, Doctor of Laws, of the ravage

an ordinary sort of weevil, or
›ut beetle, that infests vineyards.
t first, public prayers were said.
e mass was celebrated on three
ccessive days, and the Host borne
solemn procession around the
undaries of the vineyards. The in-
cts were ably defended, but the
rdict went against them. The next
p would have been to strike the
eatures with the divine anger by
eans of the church's great weapon,
e malediction. But the arthropods
l not wait for the thunderbolt.
ey decamped. Forty-one years
er they returned and a second trial
›k place. The record filled twenty-
ne folio volumes, but the action
s finally compromised when the
thorities agreed to set aside a plot
ground outside the village for the
e use of the weevils in perpetuity.
It was sometimes extremely diffi-
lt for the civil authorities to deter-
ne whether a cloud of noxious in-
cts attacking crops had been incited
their evil-doing by a fiend or were
gitimate scourges sent by God to
astise His erring children. In such
stances, the church made the de-
ion, since it presumably could
ike nice distinctions based upon
e facts of each case, and often took
er with sprinklings of holy water
d fulminations against the bugs or
ails that were troubling the farms
d gardens.

The reasoning by which animals
uld be excommunicated was that
creatures are subject to God. God
the author of canon law. Therefore
imals are subject to its provisions
d penalties. In setting the church's
aumaturgic machinery in motion
ien the peasants were vexed with
›rms, slugs, locusts, or whatever,
e ecclesiastical authorities required
st that the people pay up their
hes. The results were sometimes
ectacular. In Valence in 1585 a
osecution against caterpillars was
gued by both theologians and lay
wyers with such subtlety and pro-
city that the process dragged on
r months. "Meanwhile," wrote a
ter annalist, who lived in a more
eptical age and was aware of the
e cycle of lepidopterous creatures,
he insects died out." St. Thomas
quinas, too, in his great synthesis,
lowed that curses could be directed
ainst irrational brutes when they
ere "instigated by the powers of
ll"; that is to say, the authorities
uld take aim at Satan through the

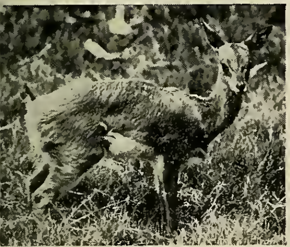
animals. This was the theological rationale of the beast trials.

Lifeless things could also be prosecuted and punished—objects that accidentally took human life and were therefore subject to formal destruction. The idea is as old as the pagan poets of antiquity. If a murderer could not be found, the instrument used was punished, for the avenging spirits of the dead, the Furies, had to be appeased. This conception, touching both things and sentient beings, had biblical analogies—the cursing of the serpent in Genesis, David's malediction against the mountains of Gilboa, which were deprived of rainfall, and in the New Testament, the curse Christ laid upon the barren fig tree of Bethany. Thus an ancient principle persisted. A French *jurisconsulte* cites an example of the effectiveness of anathemas directed against the vegetable kingdom. A priest of Burgundy excommunicated an orchard because the fruit tempted the children to stay away from mass. The orchard ceased to bear until the Duchess of Burgundy interposed and caused the curse to be lifted.

According to the archives of the French criminal courts, pigs seem to have suffered severely at the hand of the law, probably because they were so numerous, had easy access to homes and huts, and roamed the towns and cities freely as scavengers. Thus, in their role of volunteer sanitation department, it was especiall easy for them to get into troubl There was a further handicap th swine had to endure. Demons wer especially fond of dwelling in them Many were convicted of being "po sessed" and were executed, partic larly if their color was black.

When a hog was judicially burne it did not become roast pork. To e an animal caught in bloodguilt, an elevated by reason of capital punis ment to the level of man, would ha savored of cannibalism. The atm sphere of the proceedings may l inferred from these words, pr nounced by the mayor of a Fren village upon a hog convicted of ha ing caused the death of a child:

"We, in detestation and horror this crime, and in order to make example and satisfy justice, ha declared, judged, sentenced, pr nounced, and appointed that the sa pig, being detained as prisoner a confined in the said abbey, shall b by the executioners, hung and stra



gled upon a gibbet. In witness thereof we have sealed this present with our seal."

Similar trials took place in almost every country of Europe. The defendants, in addition to the species already mentioned, have included ants, asses, beetles, bloodsuckers, bulls, cockchafers, cocks, cows, eels, dolphins, goats, moles, serpents, sheep, wolves, worms, all brought to the bar of justice over a great span of time, extending from A.D. 824, when moles were prosecuted in the valley of Aosta, to 1906, when a dog was sentenced to death in Switzerland. In Switzerland, incidentally, animals could under certain circumstances appear as witnesses. If a house was broken into at night and the owner killed the intruder, the question arose whether or not his act was justifiable homicide, for he might have enticed the victim to enter and then murdered him. But the defendant could establish his innocence by producing a dog, cat, or cockerel that lived with him and had witnessed the death of the nocturnal burglar. The householder was required to declare his innocence under oath in the presence of the dumb animal. If it did not contradict him, the court held that he had cleared himself. The legal theory was that Heaven would intervene to bestow the gift of speech upon the beast rather than allow a murderer to escape.

Condemned animals that were physically in the custody of the law were killed by a variety of methods. They could be singed and strangled, burned at the stake, buried alive, sometimes tortured before being strung up on a gibbet. Animals were even put to the rack in order to extort a confession. No confession was expected, but this act of cruelty made it certain that due form was being observed. Domestic beasts met the ignominious death of human felons, for as intimate members of the human household, they were treated with the same public contempt as human vassals in a similar fix.

It must have been a vivid moment, packed with tension and high excitement, when a vast concourse of people—nobles, men-at-arms, priests in cassock and cowl, falconers with hooded hawks upon their wrists, huntsmen with hounds on leash, old men leaning on their staves, hags with their reticules, fine ladies in velvet and feathers—gathered in the

public square of the old Norman town of Falaise in 1386 to see justice done on the body of an animal. A sow was dressed up in a new suit of man's clothing, mangled about the head and forelegs, and hung, for maiming and killing a baby in a similar manner: an eye for an eye, blood for blood.

The elements of this scene are not entirely a matter of conjecture, for an artist was employed to fresco the moment of justice on the west wall of the transept of the Church of the Holy Trinity. There it remained for more than four hundred years. The expense to the state for this execution was ten sous, ten deniers, and a pair of new gloves for the hangman, who was no common butcher, but a public official, a *maître des hautes oeuvres*—master of high works. The new gloves indicated that he incurred no personal guilt in the discharge of his grisly duty but left the gallows with clean hands.

The countries in which animals have been held amenable to human law include Belgium, Denmark, England, Germany, Italy, Portugal, Spain, Scotland, Turkey, the American colonies, and the United States. The Russians, true to their historic mode of punishment, are known to have sent a billy goat to Siberia. The beast trial must have been a commonplace in England during the age of Elizabeth I, for Shakespeare includes in Gratiano's invective against Shylock this reference to such proceedings:

> Thy currish spirit
> Govern'd a wolf, who, hang'd
> for human slaughter,
> Even from the gallows did his
> fell soul fleet. . . .

Perhaps the most fascinating case of which we have knowledge, in which every legal dodge and dilatory action was employed by an inspired defense, occurred in Burgundy in 1522. The rats of the ancient canton of Lucenay, near Autun, were accused of having feloniously eaten up and wantonly destroyed the barley harvest and were ordered brought before the bishop's vicar, who exercised jurisdiction in such cases. He appointed Bartholomé Chassenée as counsel to represent the rodents. Chassenée, then a young *avocat*, later became a distinguished jurist as President of the *Parlement de Provence*, a position corresponding to chief justice. Chassenée also subse-

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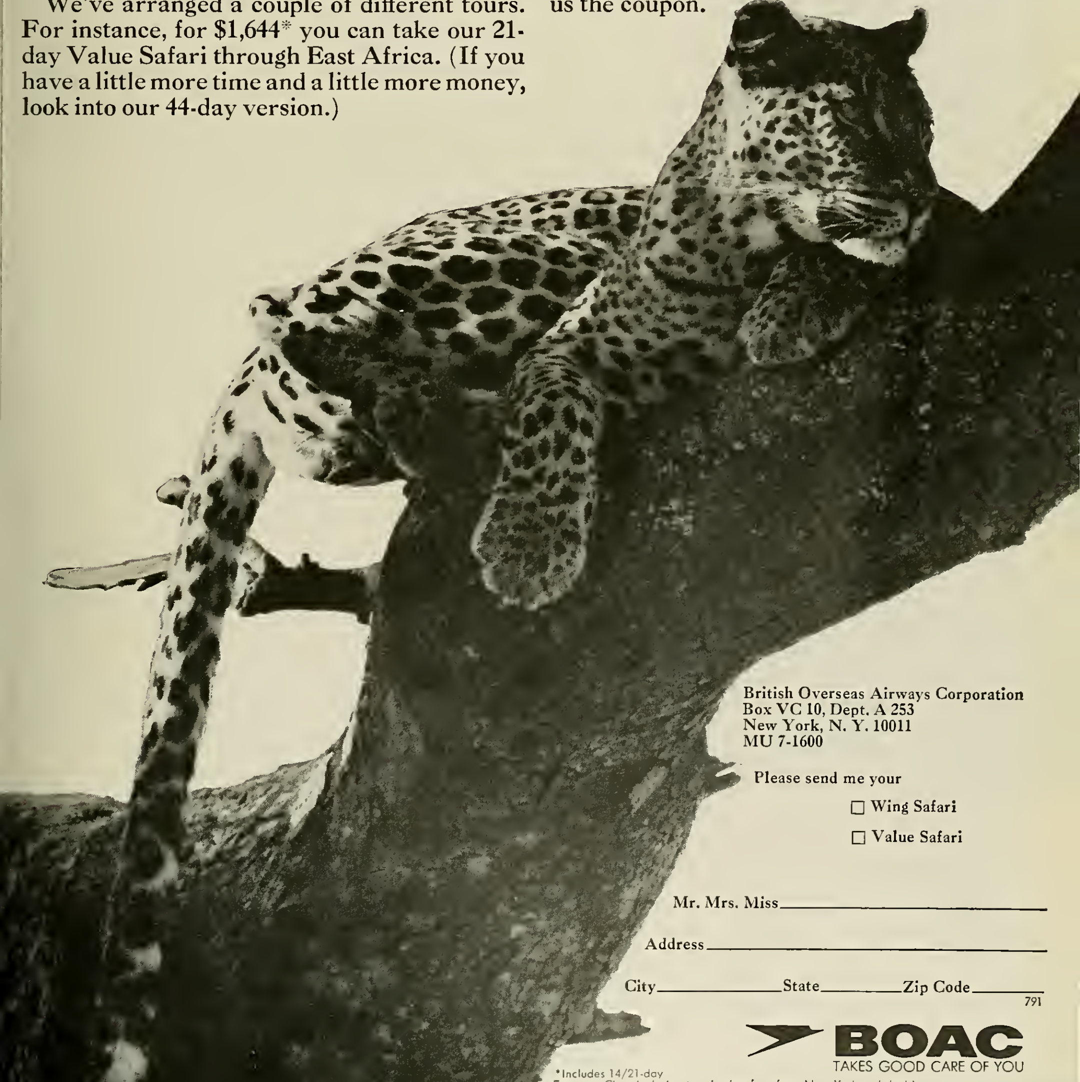

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quently wrote a scholarly treatise on the law of animals and used the precedent of Autun when he defended the Vaudois—simple, devout Alpine shepherds and farmers—who were being harassed as heretics. The rat case, Chassenée argued in defense of the Vaudois, had established that "even animals should not be adjudged and sentenced without a hearing."

At Autun, when Chassenée's clients failed to appear, their attorney attacked the summons as being defective on the ground that it had been too local and individual in character and called for the appearance of some, but not all, rats. Many, he insisted, had not heard of the accusation. The curates of every parish, therefore, were given the task of notifying all the rats residing in their ecclesiastical care. Once again the rats failed to appear. The lawyer then pointed out that the rats were widely scattered and required more time, since great preparations would have to be made for such an extraordinary assemblage. The judge granted the plea. But on court day there were no rats on hand. The ingenious *avocat* then assured the court that his clients were most anxious to obey but were entitled to have all the safeguards of justice thrown around them in responding to the summons. Under existing circumstances, they were detained by the fear of certain "evil-disposed cats kept by the plaintiffs." Chassenée demanded, therefore, that before the rats could obey the writ, the accusers should be required to post bonds guaranteeing the good behavior of their pets. At this point the complainants threw in the towel and the proceedings were adjourned sine die.

Almost a match for Bartholomé Chassenée's tour de force was the famous trial of field mice at Stelvio in the Tyrol in 1519. Field mice, it was held by theologians, had been saved from the Flood in Noah's Ark, and so were "invitees" in the order of the world. They had, then, a right to subsistence. But they were not permitted, any more than was a human being, to eat what did not belong to them. The conclusion of the story of the mice of Stelvio is delightfully summarized by Rosamond Hill in her book, *Both Small and Great Beasts* (London, 1955):

". . . after many arguments [including the plea that they did actual good by burrowing and so turning up the soil], the mice were sentenced to banishment for destroying the crops produced by the labour of human beings, but their advocate demanded, and was solemnly granted, the right that a suitable place of abode should be assigned to them in perpetuity, that in their migration to this new estate they should be given safe-conduct to preserve them from the dogs, cats and other enemies, and finally that a fortnight's respite should be allowed before pregnant mice and infants were compelled to undertake the journey."

The difficulties encountered by agricultural peoples in protecting their property from wild animals sometimes led them into the practice of the black arts. Simple peasants, finding justice through law slow, uncertain, and expensive, were tempted to try charms and spells obtained from practitioners of forbidden arts who carried on a contraband traffic in exorcisms. This placed them in competition with the church. Any poor shepherd, certainly, who resorted to sorcery to keep the wolves away from his flock risked being cursed by bell, book, and candle, and dying by stake and faggot. Thus, in a social climate that fostered belief in wizards and diabolical incarnations, in unnatural natural history concerned with such wonders as unicorns, dragons, and phoenixes, it was the logic of church and state that lower creatures caught in the toils of medieval law should suffer heavily.

Even while men still believed that evil spirits could be expelled by whipping a cat, Jean Racine caricatured the criminal prosecution of beasts in his one venture into comedy, *Les Plaideurs* (1668). In this divertissement, the great dramatic poet of classical French tragedy ridiculed the follies of judges and litigants in the time of Louis XIV. A dog is tried for making off with a capon. The defense pleads with high-flown oratory, learned references to Latin maxims, and citation of precedents drawn from Aristotle and Pausanias. The dog, it develops, has recently become a father. So the litter is brought into court to play upon the judge's sympathies.

"Venez, pauvres enfants," exclaims L'Intimé for the defense, exhibiting the pups, "qu'on veut rendr orphelins."

Dandin, the judge, is distracte

handful of people like Mary Carnwath
e trying to keep our promise to the Indians.
ut they won't make it without you.

The Hopi Indians' village of paulovi in Arizona sits on land poor, infertile and inhospitable t so far nobody has tried to take way from them.

Electricity has not yet reached Hopis. Water must be hauled n three miles away. Jobs are few far away. Only poverty and des- are close-by and in abundance.

Yet for the first time in genera- s, Mary Carnwath and people her are stirring hope among the bis.

Mary Carnwath works and s two thousand miles away, in nhattan. Her own daughter is grown-up, and through *Save Children Federation* she is spon- ng one of the village girls, 8-year- Grace Mahtewa.

The Mahtewas (two parents, ee children, one grandmother a sister-in-law) live tightly ked in a tiny rock and mud se. The father who knows ranch k but can't find any most of the r, isn't able to provide the family n even the bare necessities.

Grace, bright, ambitious and industrious, would possibly have had to quit school as soon as she was old enough to do a day's work. But, because of Mary nwath, that won't be necessary.

The $15.00 a month contrib- d by Mary Carnwath is provid- a remarkable number of things Grace and her family.

Grace will have a chance to con- ue schooling. The family has n able to make its home a little e livable. And with the money over, together with funds from er sponsors, the village has been e to renovate a dilapidated build- for use as a village center. The ter now has two manual sewing chines that are the beginnings of mall income-producing business. only a small beginning. More ney and more people like Mary nwath are needed. With your p, perhaps this village program

will produce enough money to end the Hopi's need for help. That is what Save the Children is all about.

Although contributions are deductible, it's not a charity. The aim is not merely to buy one child a few hot meals, a warm coat and a new pair of shoes. Instead, your contribution is used to give the child, the family and the village a little boost that may be all they need to start helping themselves.

Sponsors are desperately needed for other American Indian children —who suffer the highest disease rate and who look forward to the shortest life span of any American group.

As a sponsor you will receive a photo of the child, regular reports on his progress and, if you wish, a chance to correspond with him and his family.

Mary Carnwath knows that she can't save the world for $15.00 a month. Only a small corner of it. But, maybe that is the way to save the world. If there are enough Mary Carnwaths. How about you?

Save the Children Federation is registered with the U.S. State Department Advisory Committee on Voluntary Foreign Aid, and a member of the International Union of Child Welfare. Financial statements and annual reports are available on request.

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with the racket. And the puppies are not housebroken.

"Tirez donc," shouts the judge in alarm. "Quel vacarmes! Ils ont pissé partout."

But L'Intimé insists that the puddles are only the tears of the prospective orphans. Finally Dandin relents, reflecting that he does not want the puppies as a charge on the public charity. The play was praised by the man best able to evaluate such a work, Molière himself, and upon being performed at Versailles it made the Sun King laugh.

There have been some American cases. In seventeenth-century New England, Cotton Mather records the execution at New Haven of a "wretch, one Potter by name" for sodomy, the authorities first killing before him the animals that he had abused. John Winthrop, also, wrote in his *The History of New England from 1630 to 1649* of "One Hackett, a servant in Salem . . . found in buggery with a cow, upon the Lord's day." Man and cow were executed.

An attempt to prosecute an animal came to light in New York City as late as 1877 when a Celtic lady, Mary Shea, of Bottle Alley, appeared as complainant in Tombs Police Court, calling for retributive justice against an organ-grinder's capuchin monkey, named Jimmy, who had bitten her. The judge explained to Mary that he could not commit an animal. She left the courtroom in high indignation, her finger still wrapped in her handkerchief, exclaiming with scorn, "This is a nice country for justice."

The monkey, meanwhile, curled his tail around the gas fixture on the magistrate's desk and tried to shake hands with His Honor. The police blotter showed this record: Name: Jimmy Dillio. Occupation: monkey. Disposition: discharged.

The modern legal remedy for injuries by animals to human beings or to private property consists of a civil action for damages against the owner of the animal. But ancient ideas dissipate slowly and sometimes linger in forms that later generations are unaware of. Folklorists and cultural anthropologists have identified vestiges of the medieval practice of driving away unwanted animals with writs of ejectment in Scotland, Ireland, several locations in France, and in the United States, which has inherited remnants of this racial memory. Those Americans who have ever

ard casually of such a notion as iting a letter to rats, for example, ve undoubtedly regarded the anecte as a put-on. In fact, it is a seris survival of an ancient usage. An isode of this sort came to light ring a will contest in Baltimore unty, Maryland, in 1888. A necesry element in conjuring was to ovide another abode for the unwelme guests. In the Maryland case, e rats were admonished to go up e lane, then "past the stone house," d to "keep on until they came to e large white house on the right, d turn in there. . . ." They were sured that this "was Captain Low's use and they would get plenty to t there." The feelings of Captain w about this are not known.

A Maine countryman wrote a letr to the rats, rubbed it with grease make certain his correspondents uld be interested, rolled it up, and ailed it by placing it in the ratholes. ted October 31, 1888, it was adessed to "Messrs Rats and Co." and gan chattily:

"Having taken quite a deep inter- in your welfare in regard to your nter quarters I thought I would op you a few lines which might be some considerable benefit to you the future seeing that you have ched your winter quarters at the mmer residence of ——— No. 1 Seaew Street. I wish to inform you that u will be very much disturbed ring cold winter months as I am pecting to be at work through all rts of the house, shall take down ilings, take up floors, and clean out ery substance that would serve to ke you comfortable, likewise there ll be nothing left for you to feed , as I shall remove every eatable bstance; so you had better take up ur abode elsewhere." The writer en helpfully recommends a farm here you will find a splendid cel- well filled with vegetations of ll] kinds besides a shed leading to barn, with a good supply of grain, ere you can live snug and happy. all do you no harm if you heed advice; but if not, shall employ ough on Rats.' "

One cannot but admire the judius mixture of sweet reasonabless, threat, and terror set forth in s communication. The suggestion a neighbor's barn as a suitable ernative for the rats is clearly in e authentic tradition of the canny nkee.

A Naturalist at Large

The Natural History

by Marston Bates

For seventeen years I worked for the International Health Division of the Rockefeller Foundation, chiefly concerned with the epidemiology of malaria in Europe and North Africa, and of yellow fever in South America. Epidemiology is ordinarily defined as the study of the incidence and spread of disease, which is another way of saying the environmental relationships of diseases—their ecology or, in my vocabulary, their natural history. The subject continues to fascinate me, now not so much in terms of specific research as in relation to general aspects of the human ecosystem.

Disease is one of those words that everyone uses and understands—until asked for a definition. Dictionaries don't help much: disease is usually defined as a departure from a state of health, and health as the absence of disease, which is nicely circular. Clearly health and disease are polar worlds like hot and cold; but we can measure heat with a thermometer. What kind of measurement can we use for degrees of health? We have not found any so far. I like the proposal that death should be considered the absolute zero of health: as long as there is some life, there is some health. But we have difficulties with the other end of the scale, the "state of being hale and sound in body, mind or soul," as one dictionary puts it.

Body, mind, and soul cover a lot of territory, which leads to the difficulty everyone has in making classifications of diseases. The infectious diseases, those caused by the invasion of the body by microorganisms, form a neat category—and one that generally receives the most attention. In the years after Pasteur's discoveries, there was a frantic search for a pathogen, an infectious agent, for every obvious disease. Failure in this pursuit brought to light the deficiency diseases, those due to the absence of some vitamin or mineral in the diet. Starvation, I suppose, could also be called a deficiency disease. Problems multiply when we become concerned with diseases due to hereditary defects, with mental disease, and with accidents. The well-being of the soul may be the province of theology or philosophy, but everyone has ideas and opinions. Perhaps leucodermosis, which I discussed last month, could be considered a disease of the soul, and all sorts of earnest people are concerned with its epidemiology and cure.

Infectious diseases are complicated enough. From the point of view of natural history they can be classified into two large groups: the contagions, those that are "catching," passing directly from individual to individual; and those with some indirect method of transmission, such as passage through mosquitoes in the case of yellow fever or malaria.

Some of the diseases with indirect transmission have fantastically complicated life histories. The extreme is reached in the flukes (digenetic trematodes). There are some 3,00[illegible] species of these, among them the pathogens causing the human disease schistosomiasis. All pass through a stage in snails. There may be only this one intermediate host or there may be two. In the latter case both may be mollusks, one may be a snail and the other a crustacean; or the second intermediate host may be a larval insect, a fish, or an amphibian. These ultimately occur in various combinations with definitive vertebrate hosts, which may be fish, amphibians, birds, or mammals.

I used to wonder why so many parasites had complicated life histories. It would seem simpler to be able to jump directly from host to host, like the measles virus in man, to be contagious. With indirect tran-

isease

ission the hazards of finding a suit-ole new host for each stage seem im-ense. It is hard to understand, for stance, how anyone becomes in-cted with malaria—yet millions of eople do. Ordinary parasites in the ood cells of man cannot infect mos-uitoes. The infective, malarial forms ' the parasite only appear in the ood occasionally and a man has to bitten by an anopheline mosquito this precise time. This mosquito is subsequently to live for ten days two weeks or more before it in rn becomes infective, when the rasites have become lodged in its livary glands. The chances of a osquito's surviving for two weeks nature seem remote. Then this osquito has to bite a person sus-ptible to the disease—not a cow or bird or some other kind of animal. urthermore, none of the anophe-es has a really strong preference r biting people if some animal like cow or goat is easily available, al-ough a few, such as the African *opheles gambiae*, have habits that ing them close to people.

On the other hand, I can see that a rasite might not find it easy to get rectly from one host to another of same kind. Animals in nature are dely scattered; in the cases where ge herds or flocks live together, ere may be little contact between rds. There is a further difficulty in case of self-limited infections, ose in which disease is followed by munity, as with measles and small-x in man. There must always be a pply of fresh, susceptible hosts ailable if the parasite is to persist, d two potential hosts would be er than one. Also a parasite may self-limited in one host and not in other; with yellow fever, for in-nce, the virus can live in man for days or so, when the host either s or becomes immune. But the us can persist in a vector mosquito

for as long as the mosquito lives. This may not be long, but yellow fever vectors have been kept alive in the laboratory for more than thirty days. Perhaps the indirect transmission of disease, then, is a case in which ecological complexity promotes stability.

The directly transmitted diseases—the contagions—require a considerable number of possible hosts in frequent contact for survival, and this is especially true of the self-limited contagions like measles, mumps, smallpox, and the various influenzas. These diseases get along fine in urban concentrations of people, where there are always newcomers and children to be exploited. But they are less easily maintained in scattered rural populations, particularly where there is no contact with cities. It is notorious that isolated groups of people will suffer an epidemic of the common cold after a ship has come in, but the virus cannot maintain itself, and there will be no more colds until some new infecting visitor arrives.

This has led me to suspect that the human contagions may be rather new diseases, which developed when people first crowded together in settlements after the beginnings of agriculture—after the Neolithic revolution, 5,000 to 10,000 years ago. I have talked with several epidemiologists about this, and they agree that it is possible, although we can never have direct evidence. That an indirectly transmitted disease can become contagious is shown by bubonic plague, which normally is carried by fleas, but during an epidemic may take on a pneumonic form that can pass directly from person to person.

European diseases were new both to America and the Pacific islands when they were discovered. One can argue that it was smallpox, not Cortez, that conquered Mexico. The story is told in an interesting little book by E. W. and A. E. Stearn, *The Effect of Smallpox on the Destiny of the Amerindian* (Boston: Humphries Inc., 1945). "At the time of the departure of Narvaez from Cuba in order to join Cortez, smallpox was raging there severely. A pioneer vessel of the fleet brought the disease to Cozumel, whence it spread to the continent. . . . After desolating the coast regions, the disease crossed the plateau region and in the summer broke out around the lakes in passing to the land along the 'western sea.' For sixty days it raged with such virulence that the period of the raging of 'hueyzahuatl' or great pest fixed itself as a central point in the chronology of the natives. In most districts half of the population died, towns became deserted, and those who recovered presented an appearance which horrified their neighbors . . . In December, 1520, Cortez, on his way to Montezuma and the capital city of Mexico, stopped at Cholula where he was asked to nominate new Indian chiefs to replace those dead from the smallpox."

I suspect that European diseases may have been primarily responsible for the almost complete elimination of the native population of Hispaniola and other West Indian islands. The history books blame the cruelty of the Spaniards, and there is no denying their heartlessness. But it seems unlikely that this alone could have caused the death of something like a million people in a few years. In the case of Polynesia and Micronesia, the drastic reduction of the population because of European diseases is well documented.

I find the notion amusing that the ships of Columbus and his successors brought malaria to the New World and took back syphilis in exchange. The ancientness of malaria in Europe is certain. The characteristic chills and fever are described in the Hippocratic writings and many subsequent accounts. The absence of the disease from America is less certain, since there is no direct proof, but the majority of students think that it came only with the Europeans.

The case for syphilis is also unsure. The disease did make a sudden and dramatic appearance in Europe at the end of the fifteenth century, but one can argue that it had been present all along and simply underwent a sudden increase in virulence. This has been known to happen with pathogens—witness the 1918 epidemic of influenza. Whether or not syphilis was brought back by Columbus' sailors, its rapid spread across Europe must reflect pretty loose sexual habits in all ranks of people.

Historians have unduly neglected the role of disease in human events, as has been emphasized by Hans

Zinsser in his fascinating book, *Rats, Lice and History* (Boston: Little, Brown, 1935), in which there is an amusing chapter on "The Unimportance of Generals." True, it is often difficult to be sure about the diagnosis of diseases of the past, but their importance is nevertheless clear.

It seems to me, for instance, that he relations between Europe and the rest of the world in modern times result at least in part from disease patterns. The easy conquest of the Amer- can civilizations may have been due is much to disease as to gunpowder, is I remarked. The failure of the Oriental civilizations to collapse on contact with Europeans may, then, be the result of their populations having long shared European diseases. To be sure, Europe eventually conquered much of the Orient, but at the cost of a great deal of force and much rickery.

Tropical Africa, on the other hand, was long protected from European nterference by its endemic diseases, o which Europeans were very susceptible. Africa is now considered to be the principal center of human evolution, and I suspect that it was also he center for the evolution of many human diseases. The parasites of malaria, for instance, may well have evolved right along with man in the African setting. Four different species of *Plasmodium* cause malaria in man, and these will not infect any other kind of vertebrate. Various apes and monkeys also have their characteristic species of *Plasmodium*, and primates are the only mammals so infected (except for a recently discovered African rodent). The plasmodia are associated with primates, birds, and reptiles; this makes one think that the primate association is an ancient one.

Africa is also generally thought to be the original home of yellow fever, the disease brought to America with the slave ships. The ships carried both the human hosts and the African vector mosquito, *Aedes aegypti*, which bred in the water tanks on board. The mosquito became established in tropical American cities and towns, where it continued to breed mostly in man-made water containers. The virus also found suitable hosts in some of the American monkeys, and vectors among forest mosquitoes, leading to the establishment of "jungle yellow fever."

Africa remains the home of a considerable number of special diseases, with sleeping sickness (trypanosomiasis) the most spectacular. The vector of this is the tsetse fly (*Glossina*), found only in tropical Africa. Since these flies are the only vectors of the trypanosomes of sleeping sickness, the disease also remains limited to Africa. This illustrates a disadvantage, from the point of view of the parasite, in needing two different hosts.

Tropical Africa gradually ceased to be a graveyard for Europeans during the twentieth century, with the growth in understanding of the epidemiology and treatment of tropical diseases. We still have much to learn about infectious diseases, but they are no longer on the list of major human problems. The control of disease, however, has led to the postponement of death, resulting in the present extremely rapid growth of human populations, especially in tropical countries. The disease problem has been replaced by the population problem, by the need to find some way of limiting human multiplication before we destroy our planet through sheer weight of numbers.

Culture and the Camera

An Interview with Paul Byers

by Patricia Caulfield

Paul Byers is currently completing the requirements for a Ph.D. in anthropology at Columbia University and is a lecturer in photography at Columbia University School of the Arts. A professional photographer for many years, Mr. Byers now specializes in the use of both cine and still photography in anthropological research. The following interview took place in New York City.

Q. How is photography used in anthropology?

Byers: The use of photography in anthropology has mushroomed in the last decade, and I doubt if anyone knows the full answer to that question. For example, last year at Yale there was a small conference concerned with anthropological films, and many of us sat down with the mistaken notion that we knew about the uses of film in anthropology. But after a while minor disagreements began to pile up and we began to recognize that we were, in fact, talking about many different uses of anthropological film but trying to talk as though there were, somehow, one enterprise called anthropological film. I'm afraid that many anthropologists and many film makers still think this way since there is much talk within and without anthropology about *the anthropological film.* There is really no such thing. There are, instead, many people doing many different things in both motion picture and still photography. If we want to make a quick, convenient classification, we could divide these enterprises into three categories, based on the intended audience. There is, first, the film for the non-scientific public; second, the film for students; and third, the film used solely in research. The first two are called documentary films and are often ethnographic, in the sense that their intent is to convey general or specific cultural aspects in a more or less narrative fashion. The third is called the research document. The research document film—uncut, unedited footage—is usually taken under highly controlled and specified conditions for certain specific kinds of analysis. It is interesting that this last use of photography is both the oldest and the newest. Charles Darwin used still photographs—photography had just been invented—to study expressions of animals and people. Now that expressions are seen to be part of a cultural communication inventory—often as important as language—we are back to the study of expressions, and other nonlanguage forms of human and animal communication, as patterned cultural behavior, that is, as learned communication behavior.

Q. Are anthropologists taking the still photographs or film, or are they bringing in professional photographers?

Byers: Both. The professional photographer is sometimes used but there are problems here. Anthropological field trip budgets are usually too small to allow for the hiring of professional photographers, and secondly, the professional photographer usually lacks enough training in anthropology to do more than documentary films. A few anthropologists have found photographers they could work with, but for the most part their interests are too far apart. The professional photographer—cine or still —is trained to get a certain kind of interest in his film or photographs, and he is often using his medium for "creative self-expression." The anthropologist, on the other hand, is trained to avoid superimposing his own biases on his reports of other societies. This makes a partnership

rather difficult. You might say that "art" frequently gets in the way. The anthropologist tries to work in terms of the meanings or interpretations of his science. Anthropological photographs would rarely win photographic prizes, and the general photographer rarely satisfies the interest of the social scientist.

Q. What is the difference between the approach of an anthropological and a general photographer?

Byers: The general or professional photographers sometimes think that anthropology is simply a matter of describing primitive people and that photographs with exotic interest are sufficient. This kind of photography can be entertaining and visually interesting, but it is not often related to the scientific interests of the anthropologist.

To give you an example of what I mean: A group of social scientists who were studying the interaction of a family group in a psychiatric session wanted a film of such a session. The photographer, guided by his cinematic training, zoomed in closely on each person in the group who started to talk. For the most part only one person at a time was visible and then often only his head. This made the film almost useless as a record of interaction among several people. The psychiatric session had been photographed in the manner standard for television interview shows.

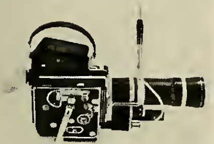
Q. Do you see any co-operation between the general photographer and the anthropologist?

Byers: Yes. Some professional photographers are studying anthropology, and some anthropologists are studying photography. It is much easier, of course, to train anthropologists to be competent photographers if you can persuade them to spend the time to learn photography.

I have found it far easier to teach photography for anthropological purposes to students with no photographic experience than to change the advanced amateur photographer to an anthropological one. If people have read the magazines and instruction books or have become caught up in the cult aspect of professional photography, they have become more

Continued on page 62

All you need to make movies is a 16mm Bolex and a lens.



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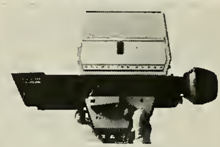


inside the tornado

A prominent weather scientist examines electrical explanations for the most violent of winds

by Bernard Vonnegut

Of all weather phenomena the most extraordinary is a tornado—the terrifying whirlwind that descends from giant thunderstorms. In itself, it is small. In contrast with those huge rotating storms, typhoons and hurricanes, its diameter is only hundreds of feet, whereas theirs is measured in hundreds of thousands. But in its brief lifetime, seldom more than an hour, the tornado demonstrates that it is unquestionably the most violent of all winds.

We now have some clues as to why this is so, and to what produces a tornado in the first place. But we are sadly lacking in some of the more fundamental facts. and scientists continue to work with little more than guesses. This is why the best experts on tornadoes are the few eyewitnesses who have seen them close up, and have lived to tell the tale.

Their evidence is the kind of whi we need more. It may be a layma description in words or a sketch crayon, or it may be the valual record on film exposed by an al amateur photographer. An examp is the farmyard scene (*see faci page*) caught by a Kansan w rushed out to the porch with l camera before he was dressed. Wh he returned for another shot t twister was gone, but he already h a color photo of interest to tornad investigators.

Even the expert cameraman m have a rewarding surprise. James Weyer, who runs a commercial st dio in Toledo, Ohio, says there w only the barest chance of his produ ing the scientifically memorab black-and-white picture shown page 28. One reason: two lumino streaks on the negative almost l

Three cameras catch the same twister at different times. Below: closing her eyes to the fearful sight and crying "Go away!" an Oklahoma woman kept clicking the camera she held above her head and took this photo.

Above: another witness, also using a simple camera, shot a formative stage of the vortex. Just before it reached all the way from cloud to ground, "something deep gray went up and touched the funnel."

Below: a late stage shot b Floyd Montgomery, tornad buff. "I'm always checking th light and lens to be ready if on comes along." After drivin 80 mph to overtake this on he stopped every half mile t record its life. He reports died when "the bottom swirle down like a lariat rope.

him to discard it as faulty. And to begin with, a tornado—much less a pair—was furthest from his mind.

If it is correct that electricity and tornadoes go together, we still face many questions, including one similar to which came first, the chicken or the egg? Very simply stated, the scientific problem is, Does the electricity play a vital role in energizing the whirlwind, or is it a spectacular but unimportant accompaniment of this wind? Let us consider some of the facts already pieced together and also look at the remaining problems.

The family of rotational winds has members ranging in size from the tiny dust devil to the giant winter storm that covers as much as half a continent. The tornado is one of the smaller members, and unlike some fairly energetic dust devils and mild waterspouts, which can form during fair weather, it apparently builds up only during a severe thunderstorm. Fortunately, statistics show that only about one out of a thousand thunderstorms breeds a tornado.

Even before the funnel-shaped vortex makes its appearance, a swirling can be seen in the base of the storm cloud. Here, rising air is forming the tornado. As the swirl increases in size and speed, the funnel drops out of the cloud like an elephant's trunk reaching groundward. At times, instead of reaching that far, it pulls back into the cloud. Now it is a hazard only to aircraft.

If it does near the ground, the disturbance raises a dense cloud of dust. Around this cloud, observers often report seeing a flock of birds circling the funnel. Actually, of course, the "birds" are roofs, bits and pieces of buildings, and other debris traveling in the whirlwind. It is reassuring to know, however, that damage is mainly limited to the path of the funnel. A house may be totally destroyed while neighboring buildings off to one side or the other may escape unscathed.

Although twisters are known to accompany thunderstorms in the tropics, they are more likely in the temperate zones, probably because these provide the greatest temperature contrasts, and consequently the most severe thunderstorms when the warm and cold air masses come together. The temperature-contrast situation also explains why tornado-

Leaving his bath and reaching for a camera instead of his clothes, farmer Bert Hoyt, 74, of Lyons, Kansas, got this revealing shot of a twister.

producing thunderstorms are unlikely in winter. The central part of the United States has the dubious honor of having tornadoes most often. Thunderstorms here, especially in the spring, are also unusually intense. The tornado season begins in February in the Gulf States, moving north in spring and summer.

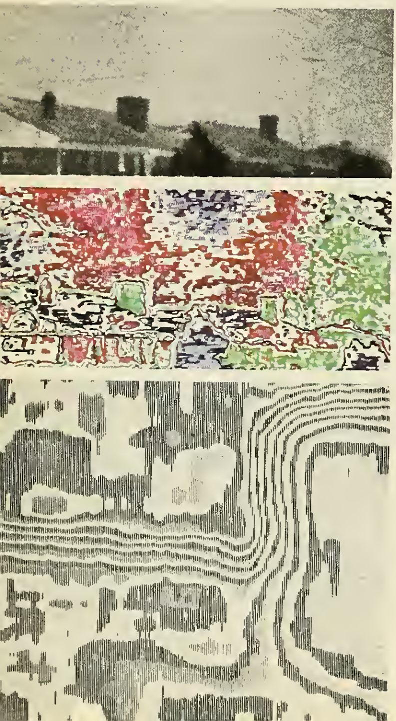
Most tornadoes form in the daytime—in midafternoon when solar energy has heated air to its maximum for the day. But they can also occur at night. Whatever the hour, the funnel rarely pauses. It usually moves with the velocity of its mother cloud—from as slowly as a man walks to as much as 70 miles per hour. Generally, its havoc at any one place occurs in a minute or less; sometimes in an incredibly brief few seconds.

Because we know definitely that extensive mountains and bodies of water affect the movement of storms, we guess that these also influence the paths of tornadoes. One idea is that they follow river valleys and avoid high hills, but we know of tornadoes that moved over mountains as well as water. When the twister crosses a stream or pond it has sometimes been seen to suck the water dry. Over larger bodies of water it becomes an unusually vigorous waterspout. Conversely, a strong waterspout passing over land becomes a tornado.

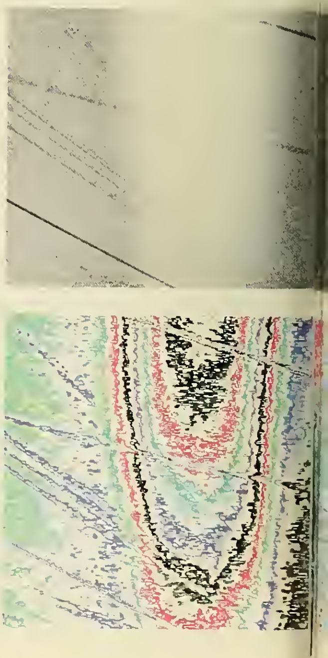
It is not always easy to track a tornado accurately by its path of damage. For instance, the havoc may actually have come from one or more tornadoes closely following one another. Furthermore, the funnel may descend, then rise where it does little or no harm, then descend again. Nor can we always count on the path totaling only a few miles. Sometimes, as with the famous tri-state (Missouri, Illinois, Indiana) tornado of 1925, destruction may extend hundreds of miles. Here, too, multiple tornadoes were probably involved.

And what about hazards to aviation? There are several accounts of airplanes and even gliders that have come through dust devils with no more than a severe jolt. But a successful airplane flight through the tornado funnel is unlikely—it would probably tear even the stoutest craft apart. Jim Cook, a weather research pilot with many hundreds of hours of flying time in and around severe storms, echoes a common sentiment when he says, "The way to practice for flying through tornadoes is to fly through mountains."

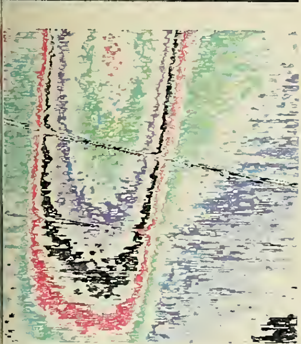
The threat from tornadoes has diminished somewhat, thanks to several developments. After a destructive twister hit Tinker Air Force Base, near Oklahoma City, two Air Weather Service officers, E. J. Fawbush and R. C. Miller, began analyzing data from many such events. They finally perceived a special,



Analysis of Weyer's nighttime photograph, above, indicated that its glowing pillars are not stray local light but a pair of tornadoes over Toledo four miles away. Left: an enlargement shows left-hand portion of the original 35 mm. photo; next, in color, an isodensitracer has scanned the same area in the negative to record its optical density contours and directions of changing density; at bottom is a still smaller area, further enlarged 10 times, that was studied. Interpretation is easier when sequence of density symbols is recorded in color. Right: two contour studies were made of an enlarged portion of the left-hand and right-hand pillars.



rather complicated set of circumstances that included an intruding "tongue" of warm, moist air in the lower part of the atmosphere, dry air above it, and at a higher altitude a strong wind called the jet stream. This combination often creates the extraordinarily severe thunderstorm that breeds a twister. The new prediction idea isn't infallible, but it has worked most of the time and was an enormous step forward. Before long the U.S. Weather Bureau, following this exciting lead, was routinely forecasting the probability of tornadoes.



Another important advance uses radar for early warning and to pinpoint the tornado's location. Besides giving a maplike picture showing storm activity over a radius of several hundred miles, it indicates the height of louds in the storm system. Tornadoes seldom come from ordinary thunderstorms—those less than eight miles high. The probability increases, radar operators have learned, when the clouds build to ten or twelve miles, penetrating well into the stratosphere. In addition, radar may show what is perhaps an indicator of the tornado itself—a small hooklike echo on the edge of the storm system. This clue can indicate the tornado's probable course.

Another warning method came from what almost everybody who listens to an ordinary AM radio set knows—thunderstorms bring static. Each lightning flash behaves like a powerful transmitter. In ordinary thunderstorms each discharge of lightning produces bursts of noise, at a rate of only about 10 per minute. But from tornado producers the electrical noise is almost continuous, easily imagined to sound like gravel pouring onto a sheetmetal roof. People in tornado country have used such static as a warning of trouble.

The radio noise has been studied by Herbert L. Jones, Professor of Electrical Engineering at Oklahoma State University. Sensitive radio direction-finding equipment has shown that the bursts average over 1,000 per minute, easily distinguishing the tornado-producer from ordinary thunderstorms. In many cases the bearing of the maximum noise informs Jones where the tornado is located in the radar echo of its mother storm.

Also helpful is modern society's network of high-speed communications. The new tornado is usually spotted promptly by amateur or professional weather observers, often also by state police or civil defense networks. Broadcasters can then interrupt their programs with warnings to people in threatened areas. This may not do much to reduce property damage, but today's forecasts and warnings certainly give people time to take proper precautions, thereby greatly reducing the annual toll of deaths and injuries.

People who have experienced a tornado often say its approach is preceded by a hot, humid situation, with scarcely any wind. Sometimes they see the swirling at the bottom of the storm cloud. Other times, two slowly rotating clouds may be slowly approaching each other. Most accounts mention frightening noise as the funnel forms and begins approaching. In colonial days, observers likened the roar to that of carriages rolling rapidly over rough cobblestones. In our times most analogies favor a squadron of low-flying jet planes.

In any case, the roar comes not only through the atmosphere but through the ground—explaining why an earthquake-like vibration is mentioned by observers who were near the tornado path. The roar probably is related to that produced by hurricanes and typhoons. But observers sometimes report a puzzling sound, "like the humming of a million bees," apparently peculiar to the approaching tornado. Then, when it strikes, people who are very near often hear what sounds like the explosion of a large bomb.

The bomb analogy is apt. After the tornado has passed, the landscape looks as if it has received a saturation bombing attack. Roofs are torn off, buildings are ripped open, houses are left askew on their foundations, and some have disappeared, leaving only cellars or footings—even these may have vanished. Automobiles, airplanes, and house trailers have been picked up, carried away, then dropped and smashed like toys. Wire fencing is sometimes twisted into a rope or rolled into a wad. Railroad locomotives are blown off the tracks and overturned, the terrific force may even destroy the ground-hugging tracks.

In addition to feats of strength, there are the clever tricks, such as leaving a flock of chickens clucking in what seems astonishment at having been plucked of all their feathers. Other times the tornado simply throws things about—wrapping sheetmetal roofing tightly around power poles, using lengths of 2x4 lumber

as spears that drive through buildings, farm animals, and, in one instance, the dual tires of a truck. Equally impressive, although more delicate, is the tornado's ability to use splinters or pieces of straw like nails and blast them deep into pieces of sound hardwood.

Vegetation, of course, is often entirely destroyed. Small shrubs and plants vanish, leaving bare earth or an excavation. The tornado can uproot trees as hurricanes frequently do, but it can also snap the trunk or twist it off like a stalk of celery.

In view of this ferocity it is understandable why the human toll is high, even though a tornado doesn't last long. On a global basis, it is estimated that hundreds of people are killed and thousands injured annually by tornadoes. Damage is on the order of a billion dollars.

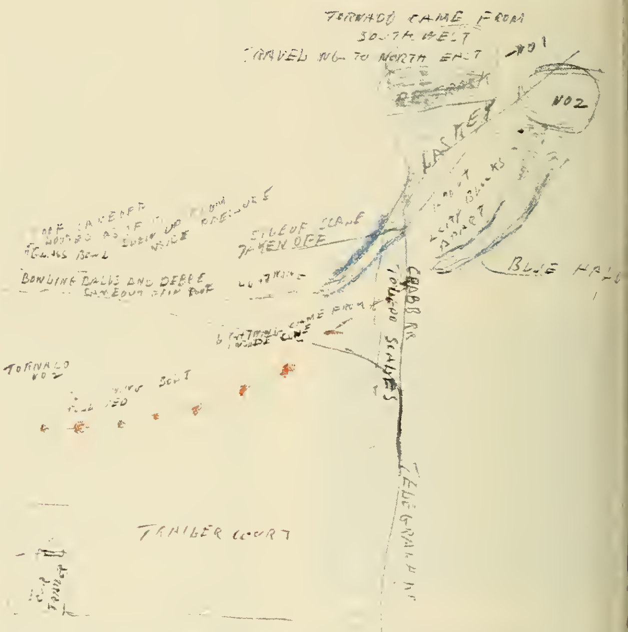
The tornado's violence is so much greater than that of other storms that a fascinating question is raised: How fast is the wind in the funnel? No measurements have ever been taken there, for we have no instruments designed for wind speeds that high.

Scientists must rely on indirect estimates, based on damage done by the wind. One of the more reliable estimates was made by Dr. Edward Brooks, of Edgerton, Germeshausen and Grier. He calculated that wind at almost 300 miles per hour was necessary to collapse high-tension cable towers during the devastating tornado that tore through Worcester, Massachusetts, in June, 1953. Other scientists, feeling that this figure was too conservative, have speculated the speed may have reached 500 or 600 miles per hour, and some have even estimated speeds greater than that of sound!

Wind speed, however, is only part of a bigger question: What makes the twister?

The most widely accepted idea today is that the tornado results from the great temperature contrast between the warm, humid air in the lower levels of the atmosphere and the cold, dry air higher up: as the warm air rises into the cool air its moisture condenses, liberating heat and causing a swirling updraft of sufficient intensity to result in a tornado. But this explains the thundercloud better than the tornado that drops out of that cloud. By itself, the temperature-contrast idea does not seem to account for tornado velocities, or even winds less than half as fast. It also does not explain why only the largest, most vigorous thunderstorms breed tornadoes. Another idea attributes tornadoes to the falling of large hailstones, which are often observed in a tornado's vicinity. But most meteorologists find it hard to see how the hail could cause the tornado updraft; furthermore, tornadoes are not always associated with hail.

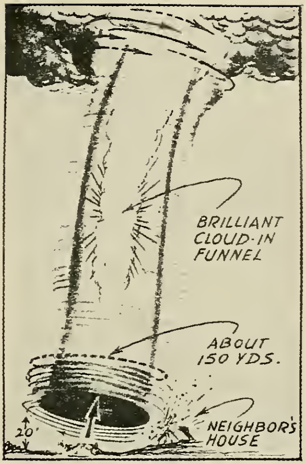
Electrical clues? Three Toledo witnesses attest that the tornado cloud brought luminous discharges. Above: "The phenomenal thing was the streaks of lightning shooting straight ahead like arrows." Below: "All at once a big hole opened in the sky with a mass of cherry red, yellow tinge in the center, black spots in the edges." Right: "The beautiful electric blue light around it was something to see!"



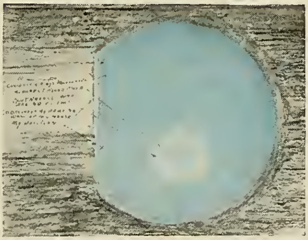
My personal interest in tornadoes began with the one that devastated Worcester fifteen years ago. That evening, upon returning from my work at the Arthur D. Little Company's research laboratories in Cambridge to my home in Scituate (on Massachusetts Bay about sixty miles east of Worcester), I received a telephone call from a friend, Wendell Sykes. He alerted me to an unusual lightning display over the ocean to the southeast. Going to the shoreline, I found this was the most spectacular lightning I had ever seen. It came from the same storm that had produced the Worcester tornado six hours earlier, and I saw it now in almost constant illumination—at least 20 lightning flashes per second. From photographs I took of the storm, then about 100 miles away, I was able to calculate that the flashes originated in a bank of thunderclouds whose tops were 12 and 13 miles above sea level. I then estimated the electrical power necessary to produce such a display and arrived at a fantastic figure—about 100 million kilowatts, which at that time was roughly equivalent to the generating capacity of the entire United States.

The bizarre idea then occurred to me that perhaps this electrical energy was in some way connected with the formation of tornadoes. A few rough calculations indicated it was equivalent to over 100 million horsepower, very possibly enough to power the winds of a tornado. I began looking through books about tornadoes to check on two things: (1) Was lightning uncommonly frequent in these storms? (2) Had eyewitnesses observed any other unusual electrical effects? The answer was yes to both.

In *Tornadoes of the United States*, by Snowden D. Flora, I found a statement by H. T. Harrison, then chief meteorologist of United Airlines, that lightning of a peculiar and intense type is almost always associated with tornadoes. In the same book an eyewitness related: "There was a screaming, hissing sound coming directly from the end of the funnel. I looked up, and to my astonishment I saw right into the heart of the tornado. There was a circular opening in the center of the funnel, about 50 to 100 feet in diameter, and extending straight upward for a distance of at least half a mile, as best I could judge under the circumstances. The walls of this opening were rotating clouds, and the hole was brilliantly lighted with constant flashes of lightning which zigzagged from side to side. Had it not been for the lightning, I could not have seen the opening or any distance into it."



R. F. Hall, McKinney, Texas: "Up the funnel I saw rings and a brilliant shimmering white light tinged with blue."



Browsing further through the literature I found that people in other times had made similar reports. There is an account of a tornado in the history of Florence written by Machiavelli. He tells of "a whirlwind which crossed Italy from east to west . . . accompanied by thick clouds of the most intense impenetrable darkness. . . ." Then: "Under some natural or supernatural influence, this vast and overcharged volume of condensed vapor burst; its fragments contended with indescribable fury and huge bodies . . . struggled, as it were, in mutual conflict whirling in circles with intense velocity and accompanied by winds impetuous beyond all conception; while flashes of awful brilliance and murky lurid flames incessantly broke forth. From these confused clouds, furious winds, and momentary fires, sounds issued out of which no earthquake or thunder ever heard could afford the least idea."

That tornado occurred in 1456. Another memorable description concerns a tornado two centuries later. Striking a church at Widecombe, England, during Sunday services, it killed and injured over 60 people. Here again we read of electricity: "Shortly after the Vicar had gone to the pulpit, it became intensely dark, and a fearful flash of lightning, accompanied by a ball of fire, with deafening thunder, rent the building, which was soon filled with smoke, dust, and a loathesome smell like that of brimstone." Many believed that the last judgment had come, and that they had entered "the very flames of hell."

We see that the luminous activity accompanying the tornado is not always described in the same way. In our times, some observers report conventional lightning, others see a luminous tube within the funnel. Still others mention balls of fire, either inside the funnel or moving along the ground. One of the more detailed accounts describes not only a luminous tube along the axis of the tornado but also a blue ribbon-like streamer of St. Elmo's fire, extending about 20 feet from the remaining corner of a demolished building.

In the course of library research I found that the association between luminous activity and the tornado was so well known long ago that the Latin language provided a word, *prester*, for such twisters. A Latin lexicon defines it as "a fiery whirlwind that descends to the earth in the form of a pillar of fire." Obviously, the electrical explanation I had fondly considered a new theory might properly be called the classical explanation.

We should make allowances, of course, for a certain amount of superstition that went into it. We can easily guess that because of the lightning, the other luminosity, the gassy, "sulfurous" odors of electrical discharges, and the fiendish destruction, ancient peoples explained all this as a manifestation of Lucifer himself.

But some probed deeper than that. I found that Lucretius, the Latin poet who had a surprising amount of scientific acumen, wrote, about 60 B.C., that there was a close association between lightning and the tornado, and went on to suggest that the air in the whirlwind was heated by the repeated lightning discharges. About 1,600 years later, Francis Bacon went so far as to assert that the tornado is just another form of lightning.

Then, with the dawn of modern science, the electrical explanation became quite popular for a while. In the United States, in the late 1830's, we find Robert Hare stating: "After maturely considering all the facts, I am led to suggest that a tornado is the effect of an electrified current of air superseding the usual means of discharge between the earth and clouds in those vivid sparks which we call lightning." At about the same time, the French physicist J. C. A. Peltier wrote an entire book that gave arguments for the electrical nature of the tornado.

This idea apparently enjoyed considerable acceptance until 1887, when Col. J. P. Findlay, of the U.S. Signal Service (which later became the Weather Bureau), enumerated no fewer than 143 reasons why tornadoes could not possibly be of electrical origin. From then on the electrical idea lost favor in scientific circles and became an almost completely forgotten concept.

I considered this strange because no rival theories were proposed. I proceeded to assemble the various electrical reports and opinions I had been reading, saw that many had some merit, and summarized them in a scientific paper, with the recommendation that they be re-examined in the light of present-day knowledge. For instance, was the updraft being accelerated by electrical forces in one of several ways known to modern science? Or, as Lucretius had indicated, did electrical heating produce a very hot chimney of air—an updraft intense enough to produce the tornado or at least add to its intensity?

The response from most others interested in tornado mechanics was not merely cool, which could have been expected; they rejected my thesis almost completely. They felt that the observations had little value because they were mostly by laymen. And if the electrical phenomena were real, they challenged, where were quantitative measurements, and where were photographs? These objections were easier made than answered. A tornado is a dangerous hit-and-run affair; it doesn't lend itself to measurements of heat and electricity or to a patiently planned photograph.

But there was another possibility. Perhaps armchair research would supply fresh and more detailed information. So, whenever a tornado was reported in the United States, I wrote to the editor of the local newspaper; in this letter I asked to hear from anyone who had seen the twister close at hand.

As is usual with tornado experiences, some testimony had a warm personal appeal. One reply, by a man in his sixties, went back to when he was eight. He remembered others in his family shouting, "Willie, get under the bed," and taking refuge themselves. But Willie knew nobody would dare come and get him. So he pulled a chair to the kitchen window and took in the "most wonderful sight of my life—a large electrical ball of fire that traveled in front of the twister." Only when the funnel came near enough to remove the barn roof nearby did he tell himself, "Willie, you better get off this chair."

My project brought much evidence that confirmed previous details and added valuable new ones. Where earlier reports mentioned a sulfurous or gassy smell, modern observers likened it to the smell from electrical machinery. Or, if they knew some chemistry, they alluded to the smell of ozone or oxides of nitrogen, which are produced by electrical discharges. People who had sought safety in storm cellars remembered that they were almost suffocated by a greenish gas. Others reported their faces and arms showed a severe sunburn, possibly because of close exposure to ultraviolet rays from the electrical activity. The funnel interior that people in previous generations had reported as a luminous tube was now described as "like a giant neon tube."

Such additional information was valuable. Yet most of it still did not answer the skeptics who doubted "hearsay" reports from laymen and wanted "objective" supporting evidence or scientific measurements. However, two pieces of evidence with good, objective credentials have turned up in the past few years, and both may lead to wider acceptance of the role played by electricity.

The first concerns a tornado that passed within six miles of the Geophysical Observatory of the Jersey Production Research Company plant, near Tulsa, Oklahoma, operated by Geoffrey Boucher. As the twister passed, disturbances were recorded at the observatory. These included not only changes in the speed and direction of the wind but abrupt fluctuations in the electric current flowing through the earth and a change in the intensity of the earth's magnetic field. Such change of intensity indicates the sudden flow of a large electrical current. From the data, Professor Marx Brook of the New Mexico Institute of Mining and Technology calculated that a current of over 100 amperes was flowing for a period of ten minutes while the tornado passed by.

From this amperage and the voltages known to exist in thunderstorms, it can be calculated that the electrical power being released might be large enough to run a tornado.

The other piece of exciting objective evidence is the already mentioned Toledo photograph taken by James Weyer, on Sunday night, April 11, 1965. From his home four miles away, he was simply shooting a thunderstorm, which he seldom did. The lens of his 35 mm. camera was set at f/5.6 to catch the spectacular lightning flashes in the west. Then, as the center of lightning activity moved eastward toward Toledo, his camera followed. Hail had been falling around Weyer's home. The hailstones now were much larger, and he

turned experimental—was the lightning bright enough to show hailstones lying in the foreground? He took a series of pictures in Toledo's direction, unaware that the city was having a tornado experience.

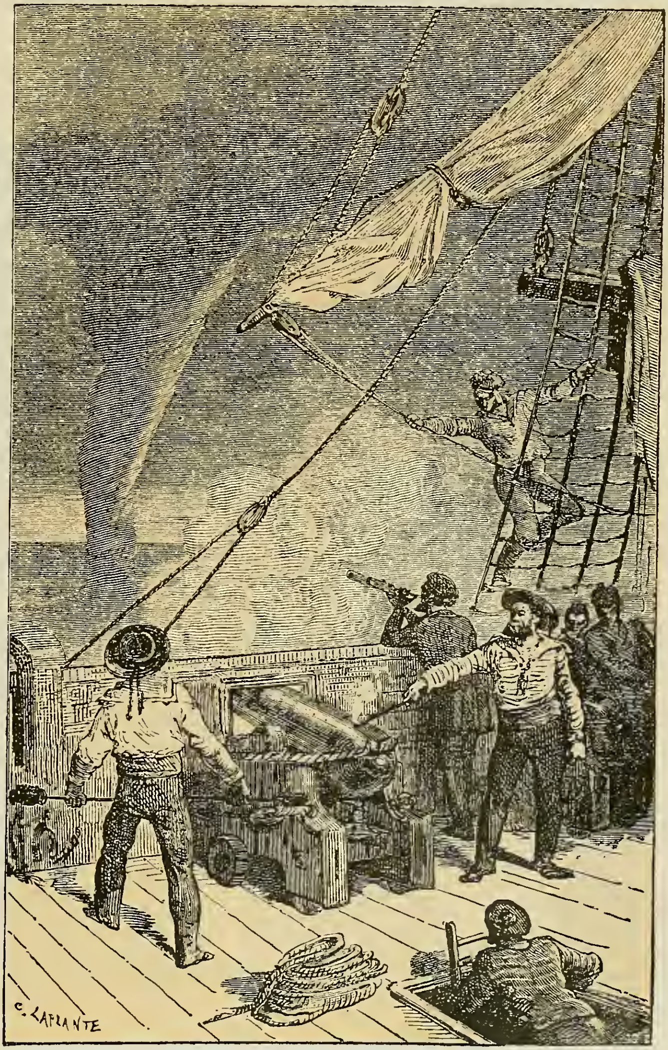
In his studio the next morning, glancing at the developed negatives, he would have discarded one, but something teased his professional mind and he examined the negative closer. Now he saw that the two somewhat vague vertical bands of brightness didn't extend past the picture area, as they would on a "fogged" negative. So he made a print. Scientific analysis as well as reports by Toledo eyewitnesses indicate that what Weyer had recorded was a pair of genuine luminous pillars—possibly tornado funnels illuminated by some kind of electrical discharge within the vortex of each twister.

The Boucher and Weyer observations go a long way to answer skepticism. They show that in at least some tornadoes there is either energetic luminous activity or a strong electrical current. But they leave more questions than they answer. For example, is the electrical activity common to all tornadoes? What is its nature? Is it a cause or a result of the tornado? If we could answer these questions, our knowledge would be greatly advanced, and it is conceivable that we could proceed to reduce the annual tornado toll.

It was once believed that tornadoes could be dissipated by firing cannons at them. A scientist now proposes that firing a guided missile into the tornado funnel would stop the whirlwind. Others suggest that if tornadoes derive their energy from electricity, it should be possible to stop them by introducing certain chemicals that interfere with electrical discharges or by distributing wires throughout the storm cloud to short-circuit its generation of electrical charge. But while we remain uncertain about what even causes a tornado, trying such preventive measures seems premature. They might even intensify, rather than dissipate, the storm.

Obviously, we need far more information. Measurements made with aircraft, radar, and electrical sensors of various kinds will be increasingly important. But scientists will continue to rely heavily on information forthcoming from the general public.

And so to my request. If any of my readers see a tornado, first take refuge. Then, if it can be done safely, take pictures of the twister—either still pictures or movies; either black and white or color. Take notes and sketch what you saw; remember that everything may be highly important. Perhaps with your help we may one day have the answer to this perplexing but fascinating scientific mystery.



In days of yore, jack-tars met a threatening waterspout with cannon fire. Today, a guided missile is a countermeasure suggested for such tornadoes, as well as their land versions.

Th

To reduce warfare the fierce Yanomamö follow a formal pattern of intervillage feasting and trading

Left: Monkey and armadillo meat are smoked in host village. Below: these guests near their satiation point.

'east by Napoleon A. Chagnon

The nature of our times is such that civilized man has become increasingly interested in alternatives to war. Can he learn anything from the behavior of primitive peoples?

In the January and December, 1967, issues of NATURAL HISTORY, I described the turmoil among the Yanomamö, a tribe of about 10,000 Indians who dwell deep in the jungles of Venezuela and Brazil. Their feuds—within, as well as between, villages—are frequent and arise mainly from quarrels over women.

But like other primitive, fierce peoples, the Yanomamö have developed controls that exist along with the violence pattern, and prevent it from ultimately leading to the tribe's self-extermination.

One method is their graded system of violence, in which they try first to settle a feud with personal duels. These range in seriousness from side slapping and chest pounding, to the club fight and, finally, the spear fight. By means of this ritual of violence they reduce the need and probability of escalating to the revenge raids and massacres desired by their *waiteri* ("fierce ones").

But they also have a less truculent alternative to war. By trading with each other, two groups of strangers become acquainted. They begin to trust each other, take turns as host at a feast, and exchange women. The resulting marriages forge in-law links between the groups. Thus antagonism is replaced by an alliance that furthers mutual aid and peace by imposing obligations to continue trading, visiting, feasting, and exchanging women.

Let me emphasize at the outset that the evolution of solidarity does not proceed smoothly nor does it achieve spectacular proportions. The staunchest Yanomamö allies, even those joined to each other by extensions of marriage bonds, never really place complete trust in each other. Nevertheless, though intervillage ties are modest, they reduce the probability of outright warfare.

The feuds over women occur because almost every village has more males than females—the result of killing newborn females so that a son can be the oldest child. The Indians justify this with the explanation that males will grow up to be warriors. A village with many warriors can better maintain its sovereignty.

But the result is that some villages have a 35 per cent excess of males, a potentially disruptive situation because Yanomamö men acquire status through satisfying their sexual appetites by what can only be described as hanky-panky. Moreover, the woman shortage is even more acute than the male–female ratio indicates, because taboos on coitus prohibit a man from enjoying his wife's favors during her pregnancies and while she is nursing children. Another factor contributes to the problem. Some men, usually the leaders, have as many as three or

four wives. Hence, other men will have none.

So the grim fact is that Yanomamö men, in the process of satisfying their sexual appetites, create dissension in the villages by chasing after the wives of other men. This frequently leads to the splitting of a larger group into small, hostile, and militarily vulnerable villages. Such villages must then establish alliances with each other or be victimized by larger neighbors.

These alliances, in turn, offer one way to solve the woman shortage. There are other ways. Several men may share one wife, or they can raid a more distant group and abduct its women. But to peacefully obtain women from some ally is the least troublesome. This is not to say that alliance is a permanent solution, for each group intends to keep its own women while getting additional women from its ally—although this will intensify the ally's shortage.

The outcome is determined by relative strength: the stronger group will emerge with more of the ally's women than it ceded in return. Consequently, each tries to demonstrate, by bluff and intimidation, that it is the superior partner. If one is obviously stronger militarily, it will try to coerce the weaker. But even a smaller village is more or less capable of fighting any other village. This may require its moving elsewhere to avoid retaliation. But it is willing to make this sacrifice in order to preserve its sovereignty. So a strong but greedy ally is wary; it would rather wait out the promises to supply women than goad a weak partner into drastic measures.

It is easy to see that all the bluffing and bristling, the attitudes about strength, sovereignty, and political coercion, do not provide an adequate basis for workable alliances. For example, the Yanomamö cannot solicit military support from neighbors with a direct request—doing so would amount to an admission of military inferiority and would invite predation by the potential ally. Consequently, the Yanomamö broaden the basis for intervillage ties. They add the feast, and the trading that accompanies it.

When the feast is the most important link, each ally can preserve its self-esteem, can even believe it does not require the alliance at all. Not that any Yanomamö would openly admit this. He prefers to consider the feast hardly more than a time to make merry, eat much food, display his fine decorations and new dance steps, flirt with the opposite sex in the host's village, do some chanting, and make demands for dogs, cotton yarn, baskets, and marriageable women.

The importance of the trading is that it provides the stimulus to visit allies regularly—a prerequisite for developing an alliance stable enough to justify reciprocal feasting. Trading continues because of the obligation to repay each item with another at some later date (an exchange practice called *no mraiha*).

If, for instance, I am given a hunting dog by one of my trading partners, I will repay him later with spun cotton, baskets, curare arrow tips, or a bow—but not with a dog. This exchange system is reinforced by a peculiar form of specialization: some villages remain chronically in need of items that they are capable of producing. This reluctance to provide for themselves is deliberate; it stimulates them to visit other villages for the trading and feasting that further solidify a friendly alliance.

The Yanomamö feast has some elements of aggression and antagonism, to be sure, because of its political and military context. This is why we find the hosts so lavish with their meats and garden produce—calculated to embarrass the guests into conceding that they could not possibly reciprocate in kind. The guests, in turn, try to outdo their hosts by devouring the generous food allotment so rapidly and ravenously that they can legitimately claim they are still hungry. This, of course, is taken in stride by the hosts, who encourage the visitors to go on gorging themselves even after their abdomens ache. The feast, therefore, contains elements of hostility, conspicuous display, solidarity, and challenge. And if there are grudges to settle, the feast may even terminate in a chest-pounding duel between the groups. After that, the participants, tired and sore, separate into pairs, hug each other intimately, and chant excitedly about their respective needs for women, dogs, hammocks, machetes, and tobacco. Elaborate promises of goods and women are made during the impassioned chanting; the participants also vow

Vomen of the host village oin in a good-luck dance o ensure success for heir menfolk, who are away unting for meat. Left, the village headman uts plantains from which a udding-like soup will be made. Below, a hunting party is on its veek-long assignment to ring back game.

o support each other to the last ditch n the face of enemy incursions.

Let us now describe, from the anomamö point of view, an ideal" feast, in which the partici-ants are well enough acquainted vith each other to visit en masse.

The headman of a village first con-ults with his brothers and other in-uential men to determine which of everal potential allies the village will nvite. The pros and cons of the pos-ible choices are carefully weighed, ecause the village's gardens can pro-ide for only two or three feasts per eason, and allies become disgruntled not invited. To invite one ally, an-ther must be ignored: the conse-uences of the choice might be dis-strous.

On the other hand, there are treacherous feasts in which hosts descend on guests, killing the men and boys and capturing the women and girls. So a headman should not only use wisdom and foresight in extending invitations; he should likewise be cautious about accepting them. However, treacherous feasts are infrequent. They indicate the alliances are still in the developmental stage; also that the victims probably had many enemies to begin with and no dependable friends. For the most part the allies with whom one usually feasts are sufficiently predictable in their intentions, and little time need be spent in discussing the possibility of being massacred.

At the host village, after the influential men select an ally they want to feast, a younger man is sent out with the invitation. It is usually accepted, and the messenger returns with information regarding the length of time—anywhere from seven to ten days—the visitors will require to travel as a group from their village.

About a week before the scheduled day of arrival, the headman cuts large quantities of green plantains, a type of cooking banana, from his garden and hangs them in the rafters of his house to ripen. This act officially marks the beginning of his village's feast period; the excitement begins at this time. On the evening of this day the young men sing and dance until very late. This will give them luck on the morrow when they go off on a week-long hunt to obtain meat for the visitors.

The hunting party, usually under the guidance of one of the older men, leaves at dawn. It carries large quantities of ordinary bananas, plantains, and other cultivated food to eat during the hunt. Occasionally the hunters miscalculate, and one of them returns to the village for more food.

Custom dictates that only specific kinds of meat, such as wild turkey, armadillo, tapir, and monkey, are suitable for feasts. Any other game may be eaten by the hunters during the hunt (but they must not eat the game earmarked for the feast). Usually a young boy accompanies the men. He spends his time at the temporary hunting camp cleaning and smoking the meat and keeping the dogs away from it. The meat is so essential that a feast will be called off if the hunters return empty-handed. Every evening that the men are gone, the women and girls sing in the village to bring the hunters good luck. During the day they work on the cotton yarn and baskets that will be given to the visitors in repayment for such commodities as dogs, bows, and arrows obtained from them in the

past. Meanwhile, the older men collect drugs from the jungle or from their gardens to ensure a large supply for the feast day, and earmark plantains and root crops that will be used.

A sociological side effect of the feast is that the schisms and resentments within the host village are temporarily overlooked; the index of co-operation rises appreciably while the village members busily prepare to entertain their visitors. The excitement increases on the morning of the feast, for by then the visitors have made advance contact with the hosts and are near enough to be able to reach the village within a few hours. By this time, too, the hunters have returned with their game and given it to the headman, who unpacks it and hangs it over his fire.

If the visitors have been invited to spend a number of days, they erect a temporary camp a short distance from the palisaded village and set up housekeeping there, relying on the host's gardens for food. Usually, however, the visitors come for only one day and will sleep in the village overnight. Whether or not they erect a temporary camp outside the village also depends on the possibility of raiders attacking the village, for the dry season permits belligerents as well as friendly visitors to travel great distances, unencumbered by water obstacles.

Joining in chanting ceremony with host headman (upright), the visiting headman accepts formal invitation to the feast.
Left: a guest squats to await plantain soup.
Below: a gaudy visitor dances into village.

By the time the visitors are near the village. the plantains are ripe and ready to be boiled into a thick soup; large numbers of bees have invaded the village to eat the flesh of the ripe fruit, and their activity drops a more or less continuous shower of sticky debris upon the people below.

Etiquette requires that the guests be fed three kinds of food: smoked meat, soup made with ripe plantains, and a cooked vegetable to go with the meat. Without this vegetable, the meat presentation would be insulting. So, besides the plantains meant for the soup, green plantains must be cut and prepared on the feast day. Unlike ripe ones, which look and taste like bananas, the green plantains resemble potatoes when boiled or roasted, and go well with meat. A more desirable vegetable to accompany the meat is peach palm. This cultivated crop is ripe and abundant during one period of the dry season, when the Yanomamö hold their feasts. If the village cultivates large quantities of yuca, this may be served in the form of cassava bread, replacing either boiled green plantains or peach palm.

Feast day requires herculean effort on the part of the hosts. They must clean the village circle for the dance, haul the debris out of their houses for their visitors' comfort, and most important and time consuming, cook the plantain soup and vegetables.

The food is prepared in front of the headman's house. For this job he usually calls on his younger brothers, nephews, and sons-in-law. But mature men would resent being commanded to work, so the headman usually initiates the activities, such as weeding the village clearing, in hopes that someone will get the message and join him. When enough people join the work party, he quietly leaves and gets another job under way. During the various activities he also observes the food preparations and offers suggestions. His younger brothers haul water from the river in gourds, peel large quantities of both ripe and green plantains, and fuel the fire with logs to keep the food boiling. As soon as each potful is prepared, it is emptied into its proper container. The plantain soup is poured into a specially prepared bark trough located in front of the headman's house; the cooked vegetables are placed on banana leaves to cool and then packed into large baskets. These, when full. are topped with smoked meat and given to the departing guests in the morning.

Excitement approaches fever pitch at around noon on the day of the feast. By this time all the work is done except for last-minute food preparations. and the visitors usually are already within earshot. The hosts are now bursting out with shrill screams and shouts (often echoed by the visitors) and are preparing red pigment and their finest feathers. The young men and women get fresh haircuts, with a blade of sharp grass serving as razor. On into early afternoon the beautifying continues, accompanied by screaming and shouting that raises the din to an almost intolerable level. Mothers decorate their children with paint and feathers, and dress the little girls in their finest cotton waistbands and harnesses. The young men and young women spend hours painting themselves. Even the village dogs and monkeys are not exempt from exterior decorating. Mischievous young men go so far as to shave the monkeys' heads and paint the simians to look like men, much to the dismay of their struggling victims.

Meanwhile. the visitors have halted nearby and are busily painting themselves in preparation for their glorious entry into the village.

Also at this time the adult men in the village take hallucinatory drugs. To the other din is added their rhythmic chanting to mountain spirits (*hekura*) and their piercing screams as they reach a state of bleary-eyed ecstasy. They prance about the area enclosed by the village's continuous. circular "house," green mucus dripping from their nostrils, exorcising malevolent spirits from the sick, and vomiting over their carefully applied paint. Occasionally the spirit moves one of them to violence, and he grabs an ax, machete. or bow intending to destroy someone or something. The others subdue and disarm him, and then chant at him to restore him to his senses.

Finally, all preliminaries are finished. The headman sends a finely decorated representative to the camp of the guests. This messenger chants a formal invitation to the headman of the visiting group and receives a staccato reply that is just as formal. But it is only the first acceptance of the invitation.

Suspense grows during the short time between the messenger's return and the entry of either the visiting headman or his delegate. Finally this person comes, resplendent in red and

Preliminaries finished, male visitors prance into the village in single file, clacking weapons above their heads.

black paint, wearing a white tiara of buzzard down, and armbands with brilliant blue and red parrot feathers protruding from them. He marches arrogantly to the center of the village and strikes the prescribed visitor's pose: legs spread, weapons held vertically against the side of the face, and head erect. The headdress and the pose signify that he has come in peace, with benevolent intentions; if the hosts bear him malice let them shoot now while he is an easy target, or not at all. After standing motionless for a few minutes, he abruptly stalks to the house of the host while all in the village cheer him. By now, the host headman has decorated himself with equal grandeur, and the two men begin to chant animatedly with each other. This is the second acceptance of the feast invitation.

After fifteen minutes of chanting, they suddenly stop; the host returns to his hammock, and the visitor squats to permit the villagers to admire his fine decorations. Presently the host directs a young man to place a gourd of plantain soup before the visitor. The soup is provided but is ignored for a few minutes. Then the visitor picks it up and drains it with one draught, returning the container to the ground. After a few more minutes the host directs a young man to present the visitor with a large basket of cooked vegetables and smoked meat. The visitor stands while the holding strap is placed around his head or shoulders, and then marches clumsily out of the village, trying to look dignified under 75 pounds of food. The villagers cheer him as he leaves to share it with his own people.

Within an hour the next ceremony begins. The male visitors assemble just outside the main entrance. At a signal from their headman the first two dancers burst into the village, circle in opposite directions, and return to their group. They are replaced by two more dancers at a time, until each visitor has had his moment of glory: strutting, quivering with excitement, parading himself before his cheering and admiring hosts—four steps ahead, stop, throw arrows on the ground, prance around them, pick them up, ahead four more steps, and so on. Then all the visitors enter the village as a group, prancing in single file, clacking weapons above their heads, and ultimately forming a circle in the center of the village. Here, they pose motionless like a string of peacocks, outwardly haughty but immensely pleased with their self-display.

By this time there is bedlam among the noisily approving hosts. The older men now enjoin each of the younger ones to invite a guest to his home. There is quick compliance. Excited by the fine display provided by their guests, the young villagers are impatient to have their own turn at prancing. Meanwhile, the wives and children of the guests have crept up to the village entrance and have carefully observed where their husbands and fathers are being lodged. They join them unceremoniously, carrying the family possessions in large pack baskets strapped to their heads.

The men settle in the hammocks provided by their hosts, this time striking the visitor's reclining pose: one hand over the mouth, eyes upward, legs crossed, one arm behind the head. (The Yanomamö are the only people in the world who can strut lying down.)

Large gourds of plantain soup are quickly set before them; these are politely ignored for a while, then eaten, refilled, and eaten, repeatedly.

The young hosts, now ready for their own glorious moment, assemble outside the village entrance. They enter in tight formation and prance several times around the periphery of the village, rhythmically clacking their upheld arrows together.

From left, clockwise: the visiting Yanomamö start in on trough containing plantain soup; later, triumphant parade with trough shows that they drank it dry; when night comes, guests and hosts start a continuous round of competitive chanting; the visit ends with trading, which takes place the next morning before the visitors depart.

When the hosts return to their houses, protocol requires the guests to gather at the trough of plantain soup. They set upon it with gourd cups, and empty it. Then they rip it from the ground and parade it victoriously over their heads, circling the village several times before they dispose of it outside the entrance.

Evening brings the marathon chanting. Shortly after darkness, one of the visiting men walks slowly around the village periphery and mumbles a rhythmic chant. This is an open challenge. When one of the hosts replies in kind, the challenger moves toward the man, and they proceed with their formal, melodious incantations. Slow and deliberate at first, the chanting is loud and violent at the conclusion, when each man is frothing at the corners of his mouth, bouncing up and down from the knees, slapping his thighs to keep time. Suddenly they stop. It's over. One of them retires and the other

again circles the village, bidding for a new partner. All night long this goes on. At dawn, hoarse and tired, the final pair of chanters creep back to their hammocks to sleep. The chanting guests have asked for, and been promised, women, dogs, bows, machetes, spun cotton, and hammocks.

Not that the requests are likely to be straightforward, particularly those for women. Should one man wish to borrow the wife of the other, for example, he might say: "Brother-in-law, I have an immense thirst. Give me water with which to quench it." This is considered reasonable.

Most feasts terminate at dawn, with the end of chanting. Now comes the trading. For this the important men gather in front of the local headman's house. The baskets of prepared food are given to the visitors at this time, and their womenfolk dutifully carry these out of the village to wait while their husbands finish trading.

This business is conducted rapidly and unceremoniously. The visitor who wants a machete frequently makes this desire known through his headman. The spokesman, in turn, requests this item from the other headman, who orders one of his co-villagers, usually a young man who cannot object, to supply the item. Spurred on by the older men, who urge him to hurry, he runs to his house, fetches the machete and throws it at the feet of the man who wanted it. The latter ignores it for a while, picks it up for a cursory examination, and throws it back down. The supplier apologizes for the poor quality of the object, while the older visitors praise its virtues.

When all trading is finished and promises have been made to repay the items, the younger men among the visitors leave the village and join their women. The older men remain to discuss future feasts and raiding parties with their hosts, also perhaps to obtain a few more prized items. Then, at a signal from their headman, they get up and leave quietly. The visit is over.

The hosts, worn out after the preparations for the feast and the dancing and chanting, repair to their hammocks for the rest of the day. Most of them sleep, but some of them recount the events of the visit. They all condemn their guests for eating like gluttons. They will do the same at the other village soon, when their turn comes.

SKY REPORTER

Comet Ikeya-Seki, the last of the record fourteen discovered or recovered during 1967, put on a quietly spectacular show during the winter months.

It had reached seventh magnitude, easily visible with binoculars, when it made its closest approach to the sun at the end of February. A tail of at least seven minutes of arc (the full moon is about thirty minutes of arc in diameter) was reported on photographs taken earlier at the Nice Observatory.

During the month of February the comet moved steadily northward through the constellation Hercules, rising earlier and moving higher in the sky each night. It was expected to become circumpolar at the latitude of New York.

MORE X-RAY ASTRONOMY

Astronomers still have only a few hours worth of X-ray source observations, painstakingly collected in five-minute segments on rocket flights. They are already finding, however, that some isolated bits of information are beginning to fit together.

One of the first sources to be discovered has been found to be a very tight binary system—two stars revolving around each other separated by as little (for stars) as a million miles. Earth, by comparison, is 93 million miles away from our star.

Another, newer X-ray source seems to be rapidly losing power. Moreover, this same source was not picked up in a survey a year earlier, although when it was found it was as strong as any in the sky. The evidence now indicates this one is a nova, a star that exploded just about a year ago.

The new X-ray source, now believed to be a binary, is Cygnus XR-2, the second such source to be found in the northern constellation Cygnus. Early last year a group at the California Institute of Technology identified the source with a visible star. By the end of the year they reported that spectra of the star showed variations in Doppler displacements (evidence of motion toward or away from the observer) every few days.

These shifts in the spectrum, the group finds, point to a pair of stars, each as massive as the sun, revolving around each other in a day or so.

More excitement surrounds the Southern Hemisphere source Centaurus XR-2. Discovered independently by Australian and California groups last year, it seems unquestionably a variable, the first such X-ray source to be found.

The Australian flights were made in April, 1967. Some 44 days later the same object was found by an American rocket flown from Hawaii. In those 44 days the strength of the source dropped by a factor of five. The same area had been surveyed in October, 1965, but no such source was detected. When it was found last year, however, it was as bright as Scorpius XR-1, the brightest object in the X-ray sky. Thus, astronomers pointed out quickly, Centaurus XR-2 apparently became 50 times brighter in a year and a half, then dimmed rapidly in the first month and a half after its discovery.

A team of astronomers from the Inter-American Observatory in Chile reported to the American Astronomical Society in Philadelphia last December that they may have identified the source with a star that is now at 13th magnitude, believed to be a variable.

EVOLUTION

It seems clear from geologic evidence that the earth's magnetic field has reversed itself a number of times. Paleontologists have wondered if increased cosmic radiation while the field was reversing could have caused a mutation rate much higher than normal and thus directly affected evolution.

Most of the globe is protected from the bulk of cosmic radiation by the earth's magnetic field. There is less protection at the magnetic poles, where the lines of force come down to the earth's surface.

The protection for the rest of the planet would be lost, however, as the strength of the magnetic field dropped to near zero during the reversal.

C. G. A. Harrison of the University of Miami argues in the journal *Nature* that the sudden loss of the magnetic shield and consequent increase in cosmic radiation dosage could not account for any abrupt evolutionary changes brought about by mutations.

Even if the earth's magnetic field had been 1.5 times as strong as it is now before it was lost briefly during a reversal, cosmic radiation dosage would have been only 60 per cent more than it is now and could have added less than 1 per cent to the human mutation rate.

Harrison suggests that rather than look for evidence of drastic changes in the mutation rate, investigators try to calculate whether the heavier cosmic ray bombardment might have caused substantial changes in the atmosphere, which might have led to climatic changes and thus, by an indirect route, to an effect on evolution.

K. D. Terry (University of Kansas) and W. H. Tucker (Rice University) suggest in the journal *Science* that if a supernova, a tremendous burst of cosmic radiation, occurred within a few hundred light-years of the earth, the sudden deluge of cosmic radiation could have catastrophic effects.

Mutation would not be important, they write, because the number of mutations would be negligible compared to existing genetic variations. But some entire species might be killed outright by the radiation.

Terry and Tucker have made their calculations from statistical studies of supernovae and current knowledge of lethal doses of radiation.

A female mouse can be permanently sterilized by a dose of 80 roentgens (units of radiation); on the other hand, thousands of roentgens are needed to kill some insects and one-celled organisms.

Plants are much more resistant to radiation, an important point, because the geologic record reveals far fewer upheavals and discontinuities in plant evolution.

Terry and Tucker calculate that supernovae could account for doses of 500 roentgen or more every 50 million years or so—doses high enough to have a dramatic effect on the earth's animal population.

John P. Wiley, Jr.

CELESTIAL EVENTS

The moon appears as a crescent low in the sunset sky as April begins, but rises higher and sets later with each succeeding night. The first-quarter moon, on April 5, sets about midnight, and the full moon, on April 12, is in the sky from sunset until dawn. Following the 12th, the moon rises after sunset and remains in the morning sky. Last-quarter moon is on April 19; new moon on April 27.

Jupiter is the only planet well placed for observation. It is high in the south at dusk, easily distinguished by its brightness among the stars of Leo, to the right of Regulus. The planet sets to the north of west about two hours before dawn.

April 8: At dusk tonight, Jupiter appears a little below and to the left of bright gibbous moon, probably the only object visible within the glow of moonlight.

April 12-13: Look for the total lunar eclipse that occurs as the full moon moves through the earth's shadow. The eclipse begins at 10:10 P.M., EST; total eclipse lasts from 11:22 P.M. on the 12th until 12:12 A.M. on the 13th; and the eclipse ends at 1:25 A.M. Times are progressively one hour earlier in each time zone to the west.

April 16: The reddish star near the waning gibbous moon is Antares, in the constellation Scorpio.

April 22: Jupiter, which has been moving retrograde away from the star Regulus, becomes stationary in right ascension and resumes direct (eastward) motion, taking it closer to the star again.

April 24: Mercury is in superior conjunction, on the far side of the sun, and enters the evening sky.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on April 1; 8:25 P.M. on the 15th; and 7:25 P.M. on the 30th; but it may be used for about an hour before and after those times.

The Esthetics of Orchid Pollination

Orchid florets have evolved a variety of zoomorphic forms, some resembling insects, others looking more like Kewpie dolls.

by Demorest Davenport

". . . their many beautiful contrivances will exalt the whole vegetable kingdom. . . ."

Charles Darwin

Since Darwin's classic *Fertilization of Orchids* first appeared in 1862, much has been written about this topic. But at the same time, little has been learned about the relation of insects' sensory abilities to these plant-insect symbioses.

During the years in which I have been engaged in the experimental analysis of symbiotic behavior (working for the most part with marine partnerships), I have never directed my attention to symbioses between flowering plants and higher insects. But recently, I had an opportunity to visit a number of sites in New England where rare native orchids were growing wild. From these visits I derived not only the satisfaction of seeing some lovely and specialized products of evolution but also the chance to think a little more about the manner in which their unique flowers have evolved.

My thoughts were perhaps initiated by my first glimpse of the strangely modified *Arethusa bulbosa*, glowing like a rose-magenta flame in the shadowy recesses of a sphagnum bog. I was reminded how, in such orchid forms as *Arethusa*, *Pogonia*, or *Calypso*, a single flower standing at the tip of a delicate stalk and frequently framed against a solid color or dark background may serve, for man at any rate, as a bright eye-catching target. And later in the spring, while looking at the delicate, spidery flowers of *Liparis lilifolia* in an isolated glen in Rhode Island, it was forcibly brought to my attention that more often than not orchid flowers are zoomorphic—they may resemble spiders or insects, even tiny birds or other animals.

Many authors have been impressed by this zoomorphism, and their impressions are enshrined in common names given to orchids, such as adder's tongue tenderwort, marbled crane fly, large butterfly orchid, green-fly orchid, green adder's-mouth, among many more. This characteristic is most marked in the genus *Ophrys*, which is symbiotic with solitary bees of the genus *Andrena*. Here the resemblance of the flowers to a female andrenid, along with mimic sex-attractants released by the flower, elicits an attempt at copulation by the insect and thus insures cross-fertilization of the flowers.

But even among orchid species that are not known to elicit such unusual insect behavior, there is a diversity of structure that gives the human observer the same broad spectrum of reactions that he may experience when contemplating a number of highly variable and grotesque animal-like figures. These reactions are particularly strong when, by means of photographic enlargement of orchid florets, the observer is "reduced" to an insect's scale vis-à-vis the flower. For instance, if one skims through the beautiful enlargements of Danesch's *Orchideen Europas* (which magnify the florets twenty times), he has the impression that a hundred animal-like faces are gazing at him from the pages; he feels just as he would when peered at by the zoomorphic sculpture of a Catalonian or Norman arch. Contemplating the combinations of structure, color, and pattern displayed by such orchid "faces," the great Romanesque sculptor Gislebertus of Autun would have been truly inspired by their grotesque nature.

Evidence can be presented, then, that a remarkable number of orchid species, far out of proportion to those similarly evolved in other angiospermous groups, show such complication as to impart to man the impression of zoomorphism. And while human reaction to the wonder and beauty of these orchids depends upon our uniquely high level of sensory and nervous activity (which we

Neither a beetle nor mottled duckling, but t blossom of Ophrys *apife*

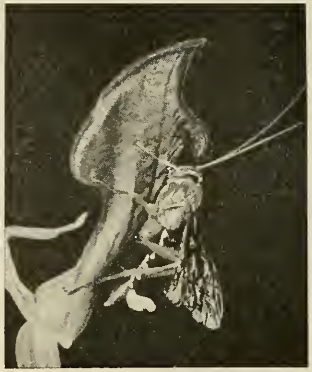
may term our esthetic ability), man was clearly not the selecting agent whose activities led to the evolution of these floral characteristics.

We know that the selectors determining the course of evolution leading to the great number of variants in orchid floral structure and pattern are predominantly insects, particularly higher Hymenoptera, Diptera, and Lepidoptera. For variants in color and pattern to be selected, variation had to occur in the nature of the visual information given out to insects. They (and perhaps a few birds) were probably the only organisms whose selective behavior could have been elicited by differences in the visual cues received.

We know from the work of Kullenberg, Dodson, and others that chemical factors are of great importance in the orientation of the pollinator to the orchid, and I do not propose to discount the importance of these attractants. It is known that increasing complexity of the floral structure may increase the efficiency of dispersal of chemical signals from the flower into air currents. But this phenomenon alone can never explain the evolution of such dramatic diversity in floral forms as exists among orchid species.

While one can imagine an insect following up a scent stream until it reaches the orchid flower without the necessity of visual cues, the significant fact is that highly complicated and, I suspect, frequently specific visual cues have indeed evolved in orchid florets. Thus, in the case of species such as *Arethusa bulbosa* with its solitary bloom, it may be that a pollinator follows up a scent trail until it comes within visual range of the brilliant flash of the rose-magenta flower, sees and "recognizes" it, and then homes in on the floral target.

It is at this point that we may theorize about ways to consider quantitatively the visual information involved in orchid–insect symbioses relative to insect physiology. First we must find out who the pollinators are, for almost nothing is known about this for the great majority of Holarctic species. But even without this knowledge some valuable studies can be made, relating the physiology of the insect compound eye to the



Some orchid species elicit pseudocopulation from their insect pollinators.

perception of visual cues displayed by the orchid floret.

Essential characteristics of the compound eye are its high sensitivity to short wavelengths, to the polarization of light, and to "flicker," as well as its ability to recognize form and irregular outline. Motion also elicits insect responses, as anyone learns who tries to catch a fly in his hand. The nature of the information given out by orchid flowers should be investigated relative to each of these characteristics.

It is possible that if one could successfully raise both a specific pollinator and its floral partner in a controlled situation, studies using models of the flower could be conducted to give us an inkling of what visual information is of greatest importance in determining the pollinator's response to a specific orchid. Such experiments would at least be the initial steps in an effort to determine just how natural selection has operated by visual means.

The ultimate questions to be answered are these: Can the characteristics of target be correlated with the known abilities of the pollinator's eye and with the competence of its central nervous system? Has evolution in orchids occurred in the direction of increasing efficiency of targets? What is the significance of the sum total of visual information displayed by the orchid floret, in terms of the insect's behavioral response?

In a series of elegant studies, C. H. Dodson of the University of Miami has demonstrated the importance of the machinery of pollination in the evolution of tropical orchids. He has emphasized the role of the insect in effecting the evolution of specialized pollination mechanisms in the orchid that exploit certain insect behaviors. But although he presents circumstantial evidence for what could be termed "gestalt" recognition by the bee *Centris*, which "charges" the orchid *Oncidium* in a territorial way, and although he points up the importance of visual recognition in pseudocopulation, Dodson neglects to emphasize the possibility that orchid speciation may depend in part upon the ability of insects to recognize highly complicated patterns of structure and color in an extremely short time span.

This possibility is of significance to those primarily concerned with the total spectrum of the behavioral capabilities of insects. It has, incidentally, become increasingly clear, as a result of the work of such investigators as the Dutch zoologist Van Iersel and the American Adrian Wenner, that learning phenomena may be of great importance in determining the activities of higher insects, particularly the Hymenoptera. The relation of the visual information received from the flower to the learning process must be taken into account, for it is entirely possible that the nature and "totality" of this information impart a high level of specificity to it, rendering its storage more efficient.

While sufficient evidence for a formal conclusion is not yet at hand, I believe that in natural selection for floral characteristics in Orchidaceae visual cues have been of greater importance than chemical ones, and that the very existence of complicated visual images in the orchids argues for the ability of higher insects to "recognize" such images. At the risk of being accused of arrant anthropomorphism, I propose that this natural selection has primarily resulted from the activities of a group with a high enough level of sensory discrimination and central nervous integration to make, sometimes at a high speed, necessary

Approaching orchids, the pollinating insect may at first respond to the bright flower spike, then to specific florets of the cluster.

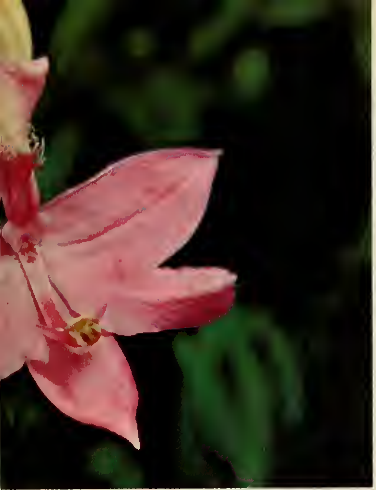
Diversity and complication in floral patterns resulted from evolutionary processes that enabled insects to become more effective pollinators.

evaluations of structure, color, and pattern and, furthermore, to "remember" these judgments in a manner perhaps simpler than, but nevertheless similar to, that utilized by human beings.

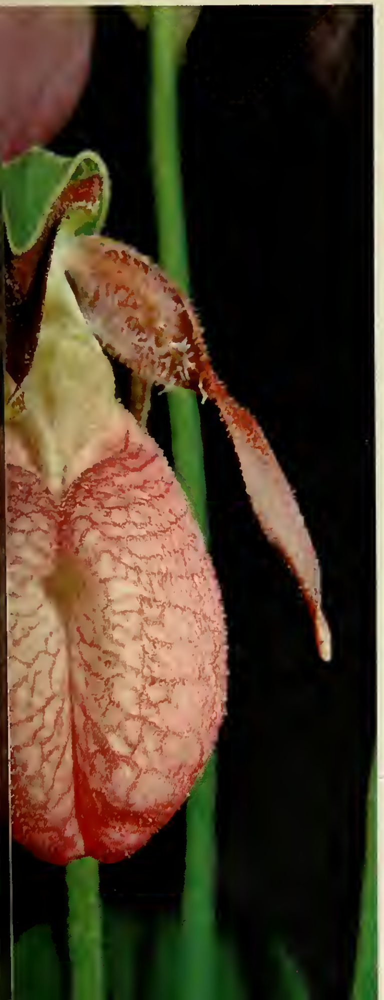
Whether or not a pollinator can make such an evaluation can only be determined by careful, interdisciplinary experiments. But in fact, the more one compares the sensory machinery of different groups of animals, the more parallels appear and the more it seems that different types of sensory machinery can deliver somewhat similar types of information to the central nervous system.

The statement is often made that the insect eye translates reality into an image only in a rather crude fashion, with considerable loss of detail. Yet, there is almost no experimental basis for this statement save that arrived at by early behavioral studies, such as those of the great Austrian student of bee behavior Karl von Frisch, who presented evidence, it is true, that bees cannot distinguish certain patterns that are quite distinguishable by us. But von Frisch did not work with entire patterns of complicated form and color; indeed, his models may have been so simple as to be meaningless in the life of the bee. We should now be able to design techniques in which entire combinations of complicated form and pattern are used as "conditioned stimuli" and should thus be able to determine how small modifications in these stimuli affect insect responses. It may be just such combinations, in which the complexity of visual information makes possible specificity by minor change, that permit recognition by the insect and allow for effective storage in its central nervous system.

Whether an orchid has zoomorphic significance for an insect can perhaps never be demonstrated, but the question of what a pollinator sees as it nears a target such as the brilliant, elfin *Arethusa* can certainly be approached. It is time that we ceased standing amazed at the unexplained floral patterns and began to test the theory of greatest probability, that these are indeed the result of evolutionary processes that gave them greater informational content (meaning) for insects.



While the capacity of the insect's compound eye and the competence of its central nervous system are poorly understood, the existence of complex visual patterns displayed by orchid florets indicates that pollinators may be capable of visually recognizing and "remembering" differences among these patterns in a manner similar to the visual discrimination used by human beings.



THERE REALLY

Geococcyx californianus hollywoodensis (Beep-Beep)

In the deserts and arid brushlands
the southwestern United Stat
there lives a fascinating cuckoo. A
though it flies weakly and infr
quently, this bird can attain 15 mp
on the ground. There its footprin
form the X-signature of a cuckoo
two toes forward and two to the rea

Nearly everyone has heard of th
fast-stepping bird, as well known i
caricature as Donald Duck, Hen
Hawk, and Woody Woodpecker. D
spite this notoriety, however, the i
teresting biology of this species h
been neglected. In fact, many peop
are surprised to learn that the roa
runner is a real bird (*Geococcy
californianus*). It is also known
snake-killer and chaparral cock.

The name "roadrunner" was i
common use in the 1850's, but
sounds more like a product of ou
increasingly mobile society. This m
bility has brought cultural diffusio
(or confusion) so that our symbo
are no longer indigenous. Nort
western totem poles and wild We
frontier shows are common at eas
ern "tourist traps." Similarly, t
roadrunner is inappropriately repr
sented far from its home—on
motorcyclist's leather jacket in Ke
tucky, on a sports car production li
in Michigan, and even as insignia
Vietnam, where it is reported to
one of the favorite emblems of t
U. S. soldier.

In the past, men lived closer
nature, choosing symbols from the
own awareness, rather than fro
mass media. J. Frank Dobie wrote
the roadrunner, "Perhaps no oth
native bird of North America, e
cepting the eagle and the turkey . .
has been so closely associated wi
the native races of this continent
To Texans and Mexicans, the roa
runner is known as *paisano*, whi
means fellow countryman, or co
patriot, clearly an indication of a
fection or spiritual kinship.

No doubt men have taken speci
notice of the roadrunner because

ROADRUNNER

by William A. Calder

its expressive posture and actions. The roadrunner has a long, cocked tail, an uneven crest, and a naked blue and red skin patch behind the eyes. It expresses surprise with a bill-clattering "brrrrrt" when alerted by a strange sound. Then, taking a quick departure, the bird lowers tail and crest so the entire body is one horizontal line, a feathered spear skimming over the ground, leaving the X-footprints about 22 inches apart, or roughly the bird's length. (It would take twelve such steps each second to go 15 mph.)

In this true-life form the roadrunner should be better known. How does it survive the desert heat? How does its behavior compare to that of non-desert birds or other cuckoos? The movie cartoon is amusing, but hardly answers these questions. The "natural history" of the roadrunner that follows is actually a composite of laboratory and field observations. The physiological studies, conducted with Knut Schmidt-Nielsen at Duke University, would have been impossible without the hand-reared roadrunners provided by Charles Lowe, of the University of Arizona. These birds were accustomed to humans. Having lost the furtiveness of their wild parents, they permitted observation of life's most intimate moments, which have never been described in field studies.

The roadrunner is at home in a hot, dry environment. Unlike the small mammals that can escape the heat by retreating to cool underground burrows, most desert birds are exposed to high temperatures on or above the ground. While heat is gained from hot surroundings, a day-active bird such as the roadrunner simultaneously produces extra heat by the exertions of hunting and defending a territory, as well as from the "resting" activities such as breathing, circulating blood, and maintaining the normal body composition. Thus the roadrunner has two heat burdens to cope with at once. Survival in the heat, often far from drinking water, would seem to demand special physiological abilities not necessary for birds of cooler and moister environments.

The search for such physiological adaptations can best be conducted under controlled conditions in the laboratory. So heat exchanges and temperature regulation of the roadrunner were studied in a system differing in appearance from the land of cactus and mesquite. Heat production was calculated from measurements of oxygen uptake, since these two are directly related. Heat is absorbed by the evaporation of water. The heat of vaporization is a constant that can be used in calculating the rate of evaporative cooling. The roadrunners were placed in respiration chambers and exposed to various temperatures. Dry air was circulated through the chambers and then analyzed to see how much oxygen the birds had used and how much water they had evaporated. Recordings of body and chamber temperatures completed the data-collecting necessary for evaluating the thermal characteristics of the roadrunner.

If the roadrunner were physiologically unusual in ways related to the desert life, this might be more apparent in comparison with a bird of wider ecological preferences. Duplicate experiments were therefore made on domestic pigeons, which are similar to the roadrunner in body weight. These pigeons are probably descendants of the western European forms of the rock dove (*Columba livia*), which ranges from cool, moist coasts to Middle Eastern deserts.

The big surprise of these experiments was that roadrunners are just "ordinary" birds, when metabolism, temperature regulation, and evaporation of water are considered. The close similarity of the pigeons and roadrunners can be seen in the accompanying graph.

Similarities in basal metabolism at air temperatures of 77° to 97° F. indicate that the size of the heat disposal problem for the roadrunner is not minimized by just producing less heat to begin with, that is, by reducing metabolic food burning. At cooler air temperatures the roadrunner and the pigeon must increase their heat production by the same amounts to balance the heat loss and preserve normal body temperatures of 104° F. With similar temperatures and heat production rates, it follows that the heat loss by "leakage" through similar insulation (feather thickness) must be the same also. When it is hot, this same insulation helps keep out desert heat.

When the environment exceeds 97° F. both species pant. Respiratory rates increase from about 29 breaths a minute in both, to 356 breaths per minute for the roadrunner, and 650 per minute for the pigeon. Perhaps the larger cooling surface in the roadrunner's larger mouth cavity vibrates slower and easier; this would explain metabolic differences at high temperatures.

The roadrunner and the pigeon are also very similar to each other in body temperatures and evaporation rates at the different air temperatures. During exposure to heat, body temperatures are regulated higher than they would be in cooler surroundings. This preserves a favorable heat balance. Unwanted heat will flow away from a 106° F. bird to a 104° F. environment without effort or water loss by the bird. In 111° surroundings, a 108° bird gains less heat than a 106° bird would.

In other experiments on panting in pigeons we found that resting pigeons could even tolerate air temperatures of 122° F. and higher quite well. Perhaps this cooling ability evolved for some other purpose. Even when it is not especially hot outside, a flying bird may dissipate

as much heat by evaporation as would be lost by a resting bird exposed to desert heat. Our figures for resting pigeons exposed to 113° F. are very similar to those reported for pigeons flying in air of moderate temperatures in telemetric studies by J. S. Hart and O. Z. Roy of the National Research Council of Canada. The main difference is in the source of the extra heat load: from within if flying; from the surrounding environment on the desert at midday if resting. Thus, instead of pointing out a specialization for the desert, this information suggests that the roadrunner's main "solution" for coping with the desert heat might simply be to take it easy in the shade if it gets too hot.

Is this laboratory conclusion realistic? Wanting reassurance from nature, I went to Arizona in the summer of 1965. Through the co-operation and hospitality of S. Clark Martin and Pablo Lucero of the U. S. Forest Service, I was able to study wild roadrunners at the Santa Rita Experimental Range, south of Tucson. I was there from June 10 to July 5, often the hottest time of the year, looking for roadrunners in a wonderland of cholla and prickly-pear cacti, mesquite, ocotillo, and other, usually thorny plants growing on the experimental range.

As might be expected, the wild roadrunners were more shy and evasive than the tame birds at Duke University. However, chances of seeing wild roadrunners should be better when they are active and moving than when they are avoiding the midday heat in the shade of a mesquite. On this assumption, I kept records of all roadrunner observations and of the duration of every search period, and then divided the observations by hours for different segments of the day. The results of this record keeping seem to verify the idea that emerged in the laboratory. Thus, except for seeking shade, the bird cannot escape the sun's heat; therefore, it runs most of its errands in cooler hours.

The outcome of such studies has been humorously predicted by George Bartholomew of U.C.L.A., "After much laborious and frustrating effort the investigator of environmental physiology succeeds in proving that the animal in question can actually exist where it lives."

Cooling by evaporation is definitely expensive if drinking water is not available locally. Doves fly long distances and may be found at waterholes in impressive numbers, but this is not practical for a weak-flying ground cuckoo. Thus, the roadrunner must budget water carefully.

The elimination of wastes is one major route of water loss. How much can the roadrunner reduce this loss by concentrating wastes? Peter Bentley and I analyzed urine samples before and after a three-day period in which the roadrunners were deprived of drinking water and, on the third day, of food. Although a concentration of wastes resulted, there was nothing to indicate concentrating abilities significantly better than those of a barnyard chicken!

The diet of the roadrunner must provide most or all of the bird's water. Many years ago, H. C. Bryant examined the crop contents of 84 roadrunners in California, using food habits to argue for protection of the species (predation on quail chicks or eggs had the quail hunters up in arms). Bryant found that the roadrunners ate 71.5 per cent insects,

The roadrunner's nest, top, is built of twigs and other handy material in a low desert shrub or cactus. To clean its feathers, a roadrunner takes a vigorous dust bath, below.

5 per cent other arthropods, 3.7 per cent lizards and snakes, 1.7 per cent small birds, 3.4 per cent mammals. and 9.9 per cent plant materials. The weight of the animals consumed is one-half to two-thirds water, so the roadrunner obtains a good amount of preformed liquid in its diet. The roadrunner "manufactures" still more by oxidizing its foodstuffs to carbon dioxide and water. (This oxidative water is not peculiar to desert animals, however; when we "burn" sugar in our bodies, the end products are carbon dioxide and water in equal proportions.)

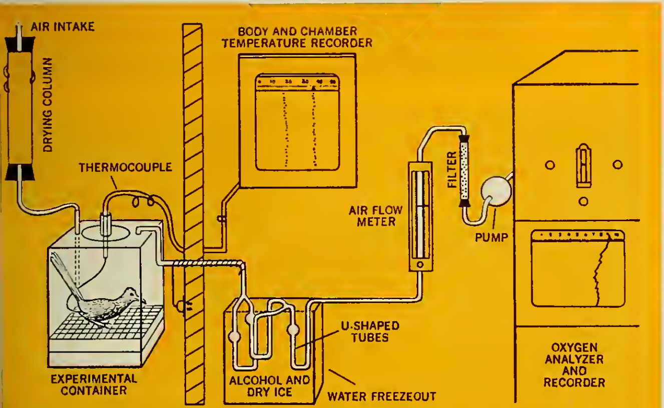
The roadrunner uses a variety of tactics in hunting for its food. Most diet items, usually insects, are simply snapped up from mesquite and ocotillo branches or are flushed from the ground by flicking the wings outward and flashing the white markings. The roadrunner has been observed following deer and waiting for the locusts and other insects routed by the larger animal.

Even when raised in captivity, with neither experience in the native range nor an opportunity to learn from adults, the roadrunners used the wing flashing in hunting for insects. The inborn hunting ability was apparent in the sudden capture of unwary house sparrows. These entered the aviary to feed on pigeon and chicken feed but ended up as variety for the roadrunners' diet of beef kidney and baby rats.

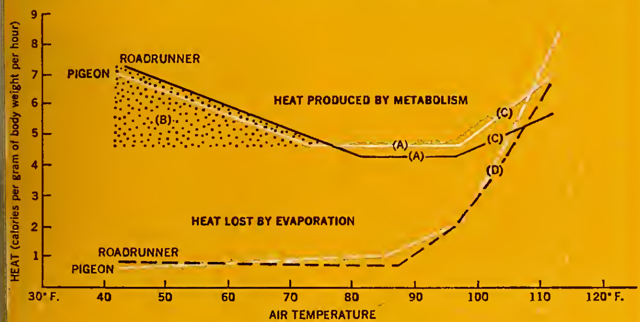
A recent survey of Arizona birds pointed out that the courtship of the roadrunner "has never been adequately described." The illustrious roadrunner has kept his secrets well in the wild! The captive birds, however, accepted my presence and proceeded to mate, uninhibited. This began with the male's territorial song, a series of descending coos that started with the bill pointed downward. As G. M. Sutton described it, each coo is pumped out on a slightly lower pitch while the head is raised higher and extended farther in each succeeding coo.

The male made his romantic advances to the female with a "love offering" of fresh food in his bill. At Duke, the availability of a mouse or baby rat was ideal for this and evoked the following display: The male raised his crest and fully exposed the bare, colored skin behind his eyes. The long tail wagged in a cocked position, like a fast metronome. The male uttered an excited *kuk-kuk-kuk-kuk* and patted his feet rapidly on the ground. The pace changed suddenly to a deep and graceful bow, the bill tip with the food offering touching the ground. He cooed during the bow—a very low, rolling coo. Tail wagging and bowing were alternately repeated. The female either moved away from his display, in which case it was repeated; or, if she was approachable, copulation ensued. He hopped and fluttered his wings as he mounted her. After copulation the hen received the gift of food. The male then circled her, the circling interrupted by a halt during which they both raised their heads and cocked their tails, flicking them sideways. The ceremony had been completed.

The cuckoo family (Cuculidae) is of interest in the study of behavior because of the variety of breeding habits represented: solitary nests with both parents attending (as in our yellow-billed cuckoo and the roadrunner); colonial nesting by the



This diagram shows the setup used to study heat exchange. As air flows through the chamber, the bird inhales oxygen and exhales carbon dioxide and water vapor. The evaporated water was collected by freezing it in U-shaped tubes. The weight of the water collected revealed how much water was lost by evaporation, since 580 heat calories are absorbed in the evaporation of one gram of water. Air flow rate and oxygen content of the air were measured, and the change from atmospheric oxygen content (21 per cent) represented the oxygen uptake of the bird. Temperatures were recorded by thermocouples in the chamber and in the bird's cloaca.



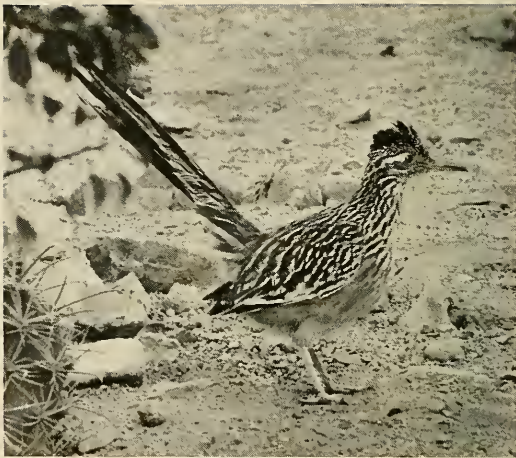
The relationship between metabolic heat production, heat loss by evaporation, and air temperature is illustrated above. In temperature range (A) normal body temperatures are maintained by a minimal, or basal, metabolism. At cooler temperatures, the birds must increase heat production above this basal rate to keep warm (represented by stippled area B). When it is hot, the birds gain heat from the environment. This heat can be lost only by evaporation, which is increased (D) by panting. The effort of panting, however, adds to heat production (C).

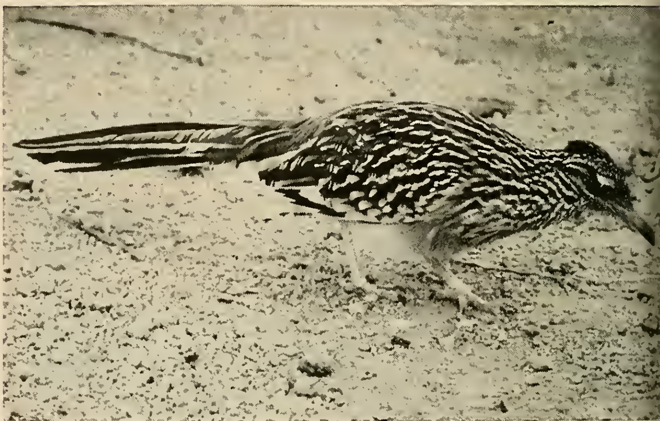
anis; and social or nest parasitism (eggs laid in nests of other species) best known in Old World cuckoos. Several acts in roadrunner courtship are found in other cuckoos. Crest erection and tail wagging are part of the courtship of the striped cuckoo, a ground cuckoo of Central and South America. The males of two species of New World cuckoos and five nest-parasitizing species from the Old World offer food to their mates, and one of the latter, the didric cuckoo, also bows to the female when presenting the food gift. Are these similarities in behavior coincidental products of convergent evolution (like the nest parasitism, which has evolved more than once) or have they a common origin? Cuckoo fossils are too rare to enable us to trace the evolution and distribution of this family in the past; so the only clues may be the morphology and behavior of present-day forms. Being a physiologist, I shall leave this for animal behavior specialists to figure out.

At Duke, the roadrunners built their nests on branches and platforms in the aviary. These nests were similar to those seen in the cholla cacti of Arizona, except for differences in nesting materials available (twigs, straw, and feathers). The female did most of the construction, but when she begged from the nest, the male would bring material to her, which she would then build into the nest. The nest had little depth in the beginning, but the sides were built up later as chicks hatched and developed. Both parents shared in the incubation and feeding of chicks. More eggs were added to the clutch after incubation had started. Just as in the wild, the young would hatch sequentially, instead of simultaneously as do robins. The newly hatched chicks were black with fine but sparse, white, hairlike feathers, and weighed 15 to 16 grams, a little more than one-half ounce.

The parents were unruffled by my appearance. They would even take food from my hand to feed the young. Usually the chicks would gape at any disturbance. If the parents had a baby mouse or rat but found no gaping mouth to receive it, they would give a soft, low, and rolling coo, which would elicit the gaping response. The parents fed the food items as they were obtained (except for killing active prey by slamming it against the ground). I never observed regurgitation of partially digested food. In the first few days after hatching, the chicks may have received digestive enzymes in addition to food, however. The parents kept their bills vertically in the chicks' mouths longer than necessary for inserting the food, and once there was the gleam of a clear fluid passing down the parent's bill.

I had been unable to successfully rear chicks hatched in an incubator (normal incubation of 17-18 days). Autopsy revealed that the chicks were unable to digest the same diet





(minced beef kidney and wax moth larvae) that was fed with success by the adults to their own chicks. Possibly the missing items were digestive enzymes that only adult roadrunners could donate.

The parents raised two chicks to the fledging stage in 1967. I observed the feeding of one chick rather closely, although not continuously. In addition to any feedings that I may have missed, the chick ate at least four newborn rats when ten days old, six on the eleventh day, and on the twelfth day nine baby rats (which totaled almost one-half of its weight). On the thirteenth day, the food intake began to taper off.

Immediately after placing food into the chick's gaping mouth, the parent shifted attention to the chick's other end. The roadrunner chicks void urine and feces in a membranous sac, which holds the wastes for neat disposal. Just as for the songbirds, this keeps the nest clean and free of strong odors that could attract predators. After putting food into the gape, the roadrunner adults awaited this sanitary delivery; upon arrival they swallowed it. The fluid portions of waste samples from this chick were less concentrated than the adult urine concentrations recorded earlier. This reprocessing of wastes to a lower water content could be significant in the parents' water economy as well as in nest sanitation.

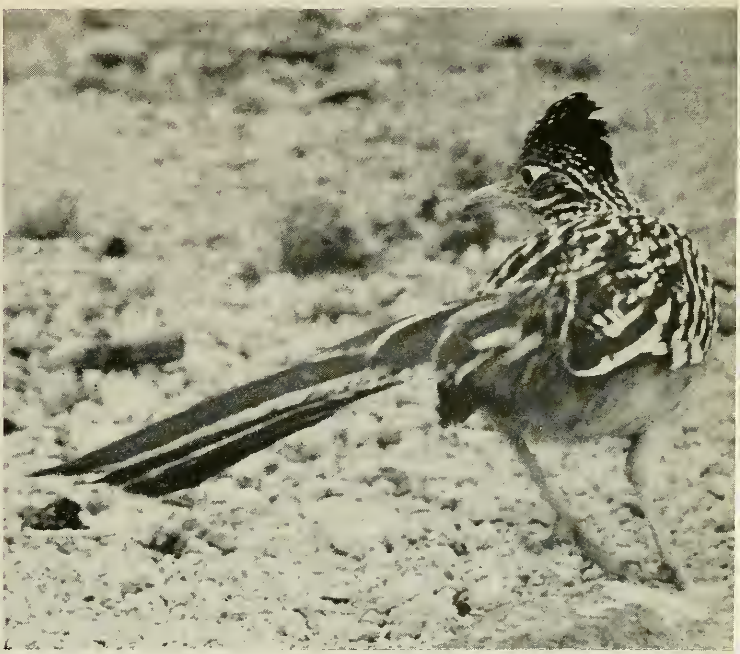
The first North Carolina roadrunner fledged on its twenty-ninth day, and immediately began exploring, pecking, and defecating frequently. The young roadrunner sunbathed just as adults do, raising the contour feathers and exposing the skin and feather tracts of its back. In another two weeks or so, the fledgling was no longer tolerated by the adults, who "planned" to have more offspring. This young bird, and later his parents with their second fledgling, were transferred to the National Zoological Park in Washington, D. C.

While witnessing the fledging of a wild roadrunner in Arizona, the last in a nest of four, I had fancied a recapitulation of the past. A low, rolling call came from the vegetation just beyond the nest. This was followed by a movement in the nest. The chick moved to the nest's edge and then leaped to the ground, scurrying off and disappearing in the direction of the summoning call. He had left a tree of sorts, just as the ground cuckoo stock must have abandoned an arboreal way of life as their kind evolved . . . so much for my imagination.

What is the evolutionary history of the roadrunner? How does running compare with flying in regard to heat production per mile? Many questions remain, and still others have not yet been raised. We already know that the roadrunner can supply valuable information about environmental physiology, desert ecology, and breeding behavior.

Our technological progress, in forms such as land development schemes and highway construction, threatens us with environmental monotony. Each region of our country has its natural essence that provides relief from the advancing sameness. The roadrunner is part of the essence of the Southwest. In the words of J. Frank Dobie, "*Nosotros somos paisanos* . . . we are fellow countrymen . . . we belong to the same soil."

standstill, the roadrunner, has an upward-directed crest tail; about to depart, left, comes parallel with the ground; ut, below, the bird is on the , using its tail as a rudder to off on a new course, right.



Primitive rock paintings and engravings of the giraffe occur over almost the whole of Africa. Starting from the west bank of the Nile we find them from Armant to Aswan, west across the vast Sahara; then through central and eastern Africa and over the whole of South Africa. On every suitable rock surface a primitive artist left his mark.

Stylistically the most striking pictures are the life-size, or greater than life-size, engravings on open rock faces. A magnificent series of these occurs in a dry watercourse in the middle of the Sahara at Fezzan, one of the most important sites. It was explored by the German ethnologist Leo Frobenius in the early nineteen-thirties. The giraffe figures there are executed with a fine rendering of detail, with careful portrayal of horns, and an attempt to depict the body pattern with a reticulate design. The giraffe must have been living in the region at the time, and its pictures are among the oldest there. The animal may have lingered on in some North African areas until 500 B.C., long after the desiccation of the Sahara, which is variously estimated to have occurred between 4000 and 2000 B.C.

Several giraffes at Fezzan have objects that have been termed plate nets depicted with them (**1**). These have been interpreted as magical signs, but most likely they represent a type of snare or a spiked wheel-trap, which is still widely used in Africa to capture anything from an elephant downward, and was also used by the predynastic Egyptians. At Gebel Aweinat in southwest Libya, where there are seventy-four engravings of the giraffe, they are often shown caught in some type of trap or snare, and more than one animal is depicted with a rope attached to one of its legs, in one case leading to a peg (**2**).

At the time these engravings were made the Sahara was a very different place from what it is today, as the Tuareg name Tassili, meaning "plateau of rivers," indicates. Tassili has some of the finest examples of giraffe

OF TH

)aintings, perhaps the most skillful)f all showing two animals sparring n a typical stance (**3**). Faithful at- ention to detail is shown in the sug- gestion of the occipital horns and the :orrect rendering of the absence of 'alse hoofs, the latter being correctly shown in all primitive art. Other fig- ures here show an ostrich, three diba- ags or perhaps gerenuks, and what nay be an okapi.

Even if we were sure of our dates for these sites it would be difficult o follow a survey of this art in chronological order. While these art- ists were living a Stone Age existence in the vastness of the desert, the in- habitants of the Nile Valley, adopting the influence of their conquerors, were highly civilized by 3400 B.C. So the giraffe paintings of the dynastic Egyptians are regarded as historic, while those of their desert contem- poraries are considered prehistoric.

The most interesting giraffe art of early dynastic Egypt appears on slate palettes, believed to be the cere- monial equivalents of a utensil that was used for grinding eye shadow, malachite and hematite being used for this purpose. They are richly fig- ured on both sides, and one of the three known palettes shows a giraffe standing on either side of a palm tree (**4**).

By about 1600 B.C., dynastic art pictures the giraffe as an alien beast and an object of curiosity. Formerly the animal had been incorporated in hunting scenes, so perhaps by this date the hunting forays had ceased to venture as far afield or else the giraffe had been eliminated from the lower Nile Valley. The last giraffe picture of dynastic Egypt is depicted on the wall of the temple of Ramses the Great, 1225 B.C., at Beit el-Wali in Nubia.

The giraffe appears infrequently in Greek and Roman writings. According to the Greek scholar Agatharchides, the animal was referred to as Camelopardalis, ". . . a name which describes the double nature of this quadruped. It has the varied coat of a leopard, the shape of a camel and is of a size beyond measure." No Greek drawings and only a few Roman pictures of the giraffe survive. And with the partition and eventual fall of the Roman Empire, the small amount of Greek and Roman knowledge of the giraffe was lost to Europe for almost a thousand years while Islam dominated the Middle East.

Despite occasional references to it, by about A.D. 600 the giraffe had become a remote figure to the best of scholars in Europe, as the dissemination of knowledge was now at a low ebb. The dearth of knowledge was soon to be counteracted by the conquest of the East by the Arabs, followed up by their conquest of Spain from A.D. 709 to 730. This boom in enlightenment occurred, not because the Arabs brought their learning into the conquered countries, for they had little learning of their own to offer, but because the new ideas of Islam provided an impetus to thought and expression. The swing in the center of learning is reflected in the study of the giraffe; for the next four hundred years almost all references to it are Arabic.

One Arabian scholar, Zakariya al-Qazwini (1203 to 1283), described the giraffe in his *Ajaib al-Makhluqat*, or *Marvels of Creation*. His account is rather fanciful, and like earlier authors he was preoccupied with its propagation:

"The Giraffe is produced by the camel mare, the male hyaena and the wild cow. Its head is shaped like that of a stag, its horns like that of cattle, its legs like those of a nine-year-old camel, its hoofs like those of cattle, its tail like that of a gazelle, its neck is very long, its hands are long and its feet are short. A scholar, Timat by name, relates that in the southern equatorial region animals of various

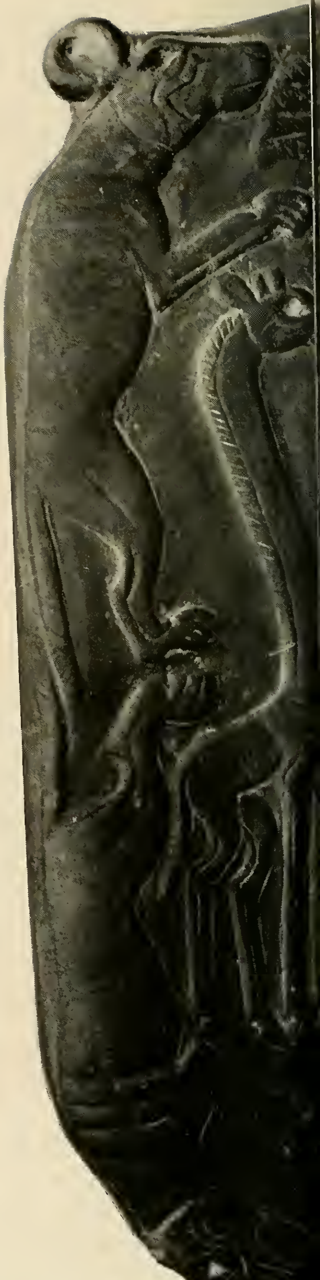
EANDERS
RAFFE
HROUGH ART
AND HISTORY

by C. A. Spinage

1. *Giraffes with "plate nets," Fezzan*

2. *Engravings at Gebel Aweinat*

3. *Giraffes sparring, Tassili*



4. *Dynastic slate palette*

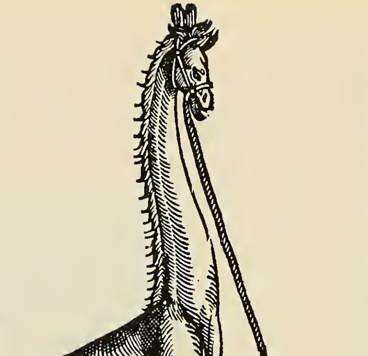
5. *At the court of Timur*

kinds congregate during the summer around the cisterns, being driven there by the heat and thirst; if an animal of a certain species covers one of another species, strange animals like the giraffe are born, the male hyaena mates with the female Abyssinian camel, if the young one is a male and covers the wild cow it will produce a Giraffe."

After this enlightening genealogy he informs us that the giraffe only has knees in its forelegs and not in the hind and that in walking it advances its left hindleg first followed by the right foreleg, instead of vice versa as in all other quadrupeds. So he was aware that its gait was unusual, but he did not have it quite right. This was the most popular of the Persian bestiaries, and there are numerous manuscripts of it. Early versions have illustrations of a rather giraffe-like animal, but after 1545 it is shown as a goatlike animal with cow's horns, a literal rendering of Qazwini's description, which persisted into the eighteenth century.

Giraffes were plentiful in Egypt in the 1400's, and after the battle of Ankara in 1402 the Sultan Faraj of Egypt sent one, among other gifts, to the court of Timur Beg, or Tamerlane, the great Tartar warrior (**5**). He had driven Faraj out of Damascus the year before, and perhaps the latter hoped to appease Timur by sending him gifts on the occasion of his grandchildren's marriage.

In any event, the giraffe was a stranger to the court and was described by one onlooker with typical amazement as "a beast called Jornufa which was strangely made and after a fashion unknown to us."



6. *From Topsell's bestiary*

Meanwhile, the giraffe was introduced to the Chinese. While there is a popular belief that Africa was known to the Chinese in ancient times, their records show no reference to that continent before the ninth century, and no mention is made of the giraffe until mid-twelfth century. Finally, in 1414 the new king of Bengal, Saifud-Din, received a giraffe as a gift from East Africa upon his accession to the throne. The Chinese ambassadors at his court showed such an interest in it that he gave it to them as a gift for their emperor, Cheng Tsu, the third emperor of the Ming Dynasty. There was an Imperial Zoological Garden at Peking that had been in existence since 1000 B.C., and although African animals such as the zebra had been taken to it in the thirteenth century by an overland route, the giraffe never figured among them, to judge by the stir that it created when this one arrived at the emperor's court on September 20, 1414. It fitted the Chinese conception of a mythical beast in Confucian ideology called the Kilin (**7**). This beast was said to have appeared just after the death of Confucius and to reappear again whenever a benevolent sovereign ruled. It was a happy portent signifying heaven's favor and proof of the emperor's virtue.

The Kilin had the body of a deer, the tail of an ox; it was covered in scales and had a single horn. The horn was covered in flesh, signifying that although capable of war it coveted peace. Symbolizing gentleness and benevolence, it did not tread upon a living thing, not even grass. It walked with regular steps and had a voice like a bell. Its food was herbs alone, and it harmed no living creature.

Rarely have such extravagant claims been made for any living animal, and once it was learned in what high esteem the Chinese held the giraffe it became a frequent gift to the court of the emperor. During a period of about ten years it held an exalted position unequalled by any animal since the deified creatures of the ancient Egyptians, becoming the emblem of perfect virtue, perfect government, and perfect harmony in the empire and the universe. The giraffe was responsible for enlarging the sphere of Chinese maritime exploration, although it provided no zoological interest to a people preoccupied with social and ethical studies. Neither in this last thousand years did the Arabs contribute anything significant to its study, but they wholeheartedly adopted it as a symbolic gift of peace and friendship, carrying on a tradition established in ancient Egyptian times. Concerned as they were with speculation and rhetoric, their writings lack any scientific value. But the lively state of their minds helped to provide a steppingstone for the slow crawl of knowledge of the giraffe from fantasy to fact.

In medieval Europe, artists portraying the giraffe—or, for that matter, any alien animal—had to create their pictures from hearsay and preconceived notions about animals they had never seen and whose form they could only guess at, if indeed they believed the animals ever existed. But with the decline of the Muslim Empire and the isolation of the Chinese, the center of learning swung to, and flourished in, Europe. The Renaissance started in the fourteenth century, but it is not until the fifteenth that knowledge of the giraffe comes almost entirely from European sources in the accounts of travelers who brought back information bit by bit from their Middle Eastern pilgrimages.

The early bestiaries of the Middle Ages seldom referred to the giraffe. Probably the slight mention given the animal by respected Greek scholars, whose writings strongly influenced the compilation of these works, created skepticism that such a creature as the giraffe even existed.

The first English bestiary to give a serious account of the giraffe, Edward Topsell's long treatise *The His-*

torie of Foure-footed Beasts, was not published until 1607. It was compiled, the author informs us, from the writings of Gesner and others. To reconcile conflicting accounts Topsell took the easy way out by referring to the "two sorts of Camelopardals," reproducing two widely differing pictures of the animal, one from a late fifteenth-century text, *Peregrinations into the Holy Land*, by Bernhard von Breydenbach, and the other drawn by Melchior Luorgius at Constantinople in 1559. From its keeper's size in the latter picture (**6**) it is hardly surprising that Topsell considered the giraffe's neck to be fifteen feet long.

And shortly after Topsell, Randle Cotgrave's French and English dictionary, which appeared in 1611, described the giraffe as "A certain spotted, and long-necked beast (gotten (as 'tis thought) by a Cammell on a female Panther) whose forelegs are much longer than her hinder; both which she moves, as she goes (in their several turns) together." And in 1613 an English traveler, Samuel Purchas, described it as "of a strange composition, mixed of a Libard [leopard], Hart, Buffe [buffalo] and Camel. . . ."

It was not until the end of the eighteenth century that any real advances were made in knowledge of the giraffe. Finally the animal had become an accepted fact in Europe, after some two thousand years of skepticism.

The giraffe emerged from the obscurity of medieval legend into reality as one of the strangest mammals on earth—an animal that played a significant part in the stability and maintenance of Middle East relationships for centuries, a symbol of peace to be offered as a gift between friendly nations, and less happily, to be exacted from the subservient.

7. *The Chinese Kilin, 1485*

Culture and the Camera

continued from page 25

concerned with the photographic difficulties and complexities than with the basic simplicity of photography. It is. after all, as easy to develop a roll of film as it is to bake a cake using a cake mix. But the popular photographic literature often makes it seem incredibly difficult. There is, to me, far too much technological mystique about photography; it is difficult to disentangle students if they have become enmeshed in it.

Q. Do you begin to teach the actual picture taking by sending students out to take pictures of anthropological subjects in their own society?

Byers: I have found it useful to start —after they can manage cameras and get reasonably well-exposed negatives—by asking the question "what do you want to discover and how can you do this with photography?" Photography, to the anthropologist, is, after all, a tool and not an end product. The first problem is to discover what the tool will do and then to help students find ways to use it in doing particular anthropological jobs. Sometimes anthropologists come back from the field with hundreds of photographs or slides or hundreds of feet of film and then ask, "what do I do with them." This, of course, is backward. I prefer to begin by stating problems or asking questions and only then using photography to help solve or answer them.

Q. Are some groups or cultures easier to photograph than others? Don't some peoples object to being photographed?

Byers: In the first place, if people object to cameras it is probably because of their experience with photographers. Cameras are not inherently unpleasant gadgets, but some people use them in ways that make other people uncomfortable. But there is another matter than can be important. In some places in the world it is conceivable that thrusting your hand toward someone in an effort to shake his might be interpreted as a threat, and he may react by either avoiding or retaliating. Now this kind of thing can happen in many other ways that we are less likely to understand. In many parts of the world, for example, a lowe status person does not talk to a higher status person while looking directly at him. It is common in Af rica, for example, for people to speal to chiefs only through their aides and sometimes commoners may no even look directly at chiefs. Th Navaho in our own country avoi looking at each other's faces. If thi is the case, a photographer will hav trouble if he insists on using his cam era as though it were an eye and con fronts people with it. It may well b that the people do not object to pho tographs, they only object to face-to face confrontations that are distress ing to them. The photographer, then must understand this and find a wa to get his photographs without vio lating a peoples' sensitivities.

This might be easier to understan if we look at the social customs i our own society. Some years ago girl in my class, who had spent th summer with the Navaho, said tha she had been unable to take picture of them because it was impolite t look at them. I pointed out that thi was highly unlikely since a peopl could scarcely co-operate socially i they couldn't look at each other. Th problem was to discover *what* on could and couldn't look at, and u der what circumstances. I asked th girl to stand up in class, and I looke straightforwardly at her breast She, of course, blushed and sat dow uncomfortably, and the class gi gled. This was, I think, a fair exan ple of the distress one can create he looks *inappropriately*. One cann always predict what is appropriate inappropriate, but the sensitive pe son, particularly if he knows abo these things. can figure it out.

I must admit. though, that in ce tain situations people object to can eras for other reasons. It would most difficult, for example, for male photographer to photogra women in an orthodox Muslim con munity. And in some places there a people who simply avoid stranger especially white ones, whether th have cameras or not. I was on chased by Arab nomads in Egypt they were even waving sticks—b cause I took photographs of son sacred goats. But I was not an a thropologist then, and I had walk in as an obtrusive and insensiti

photographer. I never found out what they objected to, but it may have been any one of several possible social violations.

Q. Most photographers have to learn how to photograph people without making them camera-conscious or without interfering with whatever they are doing. How do you teach anthropologists to do this? I suppose you can always use telephoto lenses and conceal the cameras.

Byers: There is some debate among anthropologists about the ethics of hidden cameras, but I'm firmly against hiding cameras. I will agree that, since our scientific motives are supposedly pure, we are really not using the hidden camera for any unethical purpose. But nothing, in my view, is more damaging to interpersonal relationships than the discovery that someone is spying or sneaking pictures. Anthropologists are always, in some sense, spies and that is bad enough. We do pry into people's lives so that we can understand more about our species. But if we do this by trickery or by sneaking our data, we will make enemies, and both anthropologists and photographers will be unwelcome. It may save some time and sometimes one can get records that are otherwise impossible to get, but I don't think it pays off in the long run. Incidentally, I discovered a long time ago that the taboo against photographing certain things, even in our own society, is often not a matter of what you take a picture of, it is the photographer's manner and motive.

I have found, for example, that some students could go into subway trains—where it is difficult to hide—and take pictures of people with no fuss. No one seemed to mind. But other students evoke a lot of hostility doing this. I can't fully explain this except to say that people who assume that what they're doing is all right and who do it openly, and perhaps with some personal warmth can take photographs almost anywhere with little objection. On the other hand, the photographer who is frightened that he is doing something wrong or something that his subjects will disapprove of is very likely to engender the disapproval he expects. I used to tell students to carry their cameras or wear them

around their necks all the time—even when the cameras weren't loaded—so that they would get over the feeling of embarrassment. Some students objected that they felt silly wearing cameras to class or to church or such unlikely places. But I really feel that a person will manage the picture-taking enterprise more easily when his camera is no more embarrassing to him than his wristwatch.

In all my classes I have had a rule that students can bring cameras and take pictures of anything they like during class. They need some practice in a protected situation, and they also need some experience in being photographed and discovering that some people do it more comfortably than others. I always find that some people take photographs of me without disturbing me even though I can see them doing it. But other students make me feel quite uncomfortable. I cannot explain exactly what happens in the two cases. and I don't think we could make rules about it anyway. One either discovers how to be comfortable taking pictures or he doesn't. I have no recipes except for trying. Sometimes it has been helpful to students to see photographs of themselves taking pictures.

Q. What is your own special interest in anthropological photography? You are going to Africa this year. What is your project?

Byers: My particular interest in anthropolgy is in studying the patterns of learned human behavior that we call communication. Everyone is familiar with the culturally specific communication enterprise called language, but there is much more communication behavior that is important and that we know very little about. I'm talking now about such things as facial expressions. gestures, tones of voice, touching, what and where we look when we are in communication with other people, the distances and body or head orientations we adopt when we communicate in different situations or different degrees of intimacy or social distance. Then there are matters of shared rhythms such as small head nods on accented syllables that people use to keep track that others are listening and understanding. There is all the non-verbal learning that children do before they acquire language. We are beginning, in anthropology, to sort out these things and see this behavior as patterned, just as language is, and culturally specific. That is, each culture arranges these things differently. The new formal name for this subbranch of anthropology is semiotics.

Now it would be a formidable task to try to collect sound film from which we could discover and analyze all of a culture's non-verbal communication behavior. So I have tied this work to a specific area—one that relates to immediate worldwide problems. I am going to make fully synchronized sound film relating to that enterprise we call the school. This means classes and teachers, individual pupil—teacher relationships, paired pupil relationships, pupil and parent relationships, and so forth. You see, each cultural group carries on these enterprises in its own particular way, but the school is an invention that is used everywhere as though it is the only and most appropriate communication setting and procedure for carrying out the formal education of children. So what I will study is the relation of these non-verbal communication behaviors in particular cultural groups to the communication demands that are inherent in the school. You might say that I'm going to study the school as a communication medium and see how well it fits different groups.

This will have to be done with sound film since I will be looking at pieces of behavior that are too brief and often too small to observe with eyes alone. Also when several people are emitting this behavior simultaneously, it is quite impossible to see it all. With film records and a projector that can slow down the behavioral performances, we will be able to observe and make some analytic sense out of human enterprise that is terribly important but about which we know very little.

Q. Do you think you'll be able to say how schools should work?

Byers: No. nothing as pretentious as that. I will be pleased if I can do no more than discover whether or not a certain synchrony of rhythms in an interacting group, or a char-

acteristic spatial configuration in a culture, is also crucially important in learning situations. Or whether certain of these things are important in one culture but not in another—or in certain kinds of situations and not others. But I really do not know what to expect. So far we have only broad guidelines for this kind of research. We know some of the things to look at and some ways, or methods, to use in analyzing the film records. Otherwise it is a fairly unexplored area of comparative research. It is now possible to do this kind of research because other anthropologists have worked out the theoretical bases and certain analytic methods, and also because our technology is now good enough and easy enough to be manageable by an anthropologist-photographer and a Kenyan assistant. The only real obstacle is the expense of equipment.

Q. Why do you have to go to Africa? Why can't you do this work here?

Byers: The anthropologist always finds it difficult to study his own culture. Everything is so familiar that he loses his objectivity without knowing it. But there are two even more important reasons for going to Africa. Almost all we know about human communication behavior has been learned from the study of people in our own related societies, and we badly need records from other, different societies for comparative study. The second reason is that in Kenya there are many different cultural groups, most of which now have schools.

Q. When you get back, I will be interested in seeing the film you have taken.

Byers: It will not be too interesting in cinematic terms. I will have many uninterrupted stretches of film, each eleven minutes long—about 400 feet of film. To someone accustomed to the interest of edited movies, these records are almost completely without interest or excitement. It becomes exciting, to the anthropologist at least, only after many hours of repeated observation and analysis when one begins to discover the underlying patterns of behavior on which human relationships are built.

Book Essay: The Botanist's Library

by Richard M. Klein

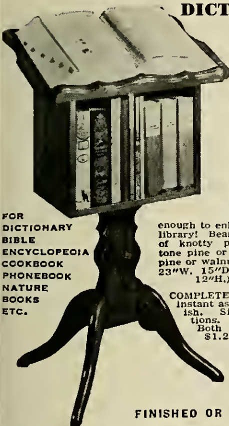
When I was at the New York Botanical Garden I received about two hundred letters a year from school children and adults asking me for information on one or another area of plant science. Many of these requests were specific, the individual wanted to know some special detail of photosynthesis or how to care for an African violet. All too often, however, the request was in the form of "send me all the information you have on botany."

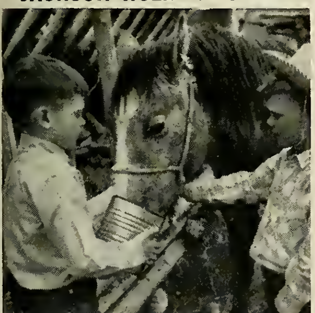
When the editors of NATURAL HISTORY asked me to prepare an article on the available books in plant science for the non-professional with an interest in plants, it was obvious that I would jump at the chance. There were, in my mind, several criteria for books to be included in such a reading program. The most important of these was that the book be readable. I know that the person interested in a field wants to avoid the textbook approach. Other criteria are equally obvious: the books must be accurate, up to date, available, and reasonably inexpensive. For this reason, most of the readings suggested in this article are paperbound. There is a further advantage in recommending paperbound books; people realize that the book itself is not permanent, and after a reasonable time, it can be given away or thrown away. This is as it should be, for plant science is rapidly changing its factual and conceptual base, and what we think is true today may not be true tomorrow. Parenthetically, this is one of the fascinations of working with, and learning about, living things.

For the convenience of man, who cannot grasp huge blocks of knowledge at one time, plant science has necessarily been subdivided into more or less arbitrary fields. A scientist may be known as a plant ecologist, studying primarily the relationships among organisms; a plant physiologist, who studies how plants do what they do; or a plant morphologist, who studies the structure of plants. Because of the tremendous amount of information available in each of these areas, specializations in writing have become necessary, just as specializations in teaching and research have developed. More and more, we are realizing that a knowledge of many areas is vital if we are to be proficient in our own little niche within the broad scheme of botany, and much of the most exciting research and thinking is now being done in the interfaces between areas of specialization. Physiological ecologists or ecological morphologists are becoming more common in research institutes and universities—and this is a very good and healthy situation. It does, however, confuse the reader somewhat, since all of us tend to pigeonhole ideas, as well as people. Even with book lists, such artificial separations are necessary, but the reader should remember that the primary focus is on plants and that all of the various subtopics and specialties eventually come back to the plant.

Just as in politics—or even gourmet cooking—it is generally useful to start with an over-all survey of just what plant science is all about. Although the name for such a survey is schoolish, the term General Botany has been used. I think that the typical reader is likely to have his primary acquaintance with the more highly evolved seed plants and has missed the algae, fungi, mosses, and liverworts. Hence, the best place to start is with some very fine books that depend for their impact on photographs and drawings. Two books can be highly recommended for their visual impact: *The Plant World*, by Jean Vallin, and the beautifully illustrated *The Plants*, by F. W. Went, one of the "Life Nature Library" books. From this base, the more wordy and less pictorial *Basic Facts of Botany*, by C. B. Cabral, and *The Plant Kingdom* (second edition), by H. C. Bold, will permit the reader to fit most of the rest of the books into a general conceptual framework.

There are many different groups of plants that have evolved over the billion or so years that life has existed on earth. Each of these groups is suf-





ficiently well known to have formed around it one or more gaggles of plant scientists who study the plants in that category. There are many different ways of looking at a particular group of plants. In some instances, the evolutionary history of the group or its classification is the primary object of the research. In other instances, it is the development of the plant or its chemistry or economic importance that is the focus of interest. One most fascinating study is the basis for plant names. Professor Liberty Hyde Bailey wrote *How Plants Get Their Names*, which has recently been reprinted. How I wish I had his smooth style!

Any series of books that deals with the plant kingdom should include E. C. Large's *The Advance of the Fungi*, and C. M. Christensen's *The Molds and Man*. Both cover aspects of the field of mycology, but both go much further and show how these organisms have affected the politics, history, and even the art of Western man. It has been said that the composition of the police forces in the cities of the eastern seaboard was determined by the potato late blight fungus in Ireland—and strictly speaking, this is probably true.

Most bacteriologists won't admit that they are botanical specialists, but they really are. A. S. Sussman's *Biology Through Microbes* and A. Boivin's *Microbes* will serve as introductions to this important field.

One of the best book titles that I know is *A House Is Not a Home*, by Polly Adler. Unfortunately, plants haven't as racy a history, but a perfectly splendid title is *Algae: Grass of Many Waters*, by L. H. Tiffany. The book, although somewhat dated in terms of modern concepts, is as good as its title. Two other books are worth while in a survey of the algae. M. L. Guberlet's *Seaweeds at Ebb Tide* and the more textbookish *Algae and Fungi*, by C. J. Alexopoulos (who keeps speaking of "us Texans") and H. C. Bold (his colleague at the University of Texas). This book was published in 1967 as part of a series to be used as supplementary reading at the college level and should be read after the others listed above.

In spite of their importance in nature, not much has been written about the other "lower" plants. Ross E. Hutchins has written *Plants Without Leaves*. I particularly commend his photographs and his discussions of lichens, mosses, and liverworts. For those who have a reasonable background in botany *The Structure and Life of Bryophytes*, by E. V. Watson, can be recommended as being comprehensive, accurate, and precise, but it is not an easy book for the beginner. H. S. Conard's *How to Know the Mosses*

and Liverworts is more in the nature of a field identification guide, but does have some general information. *Nonvascular Plants: Form and Function,* by W. T. Doyle, is, again, a text supplement, but valuable for those of you who are especially interested in the dynamics of the lower plants.

The structure of plants can be examined at a variety of levels, ranging from the unaided eye, down to the electron microscope and interference microscope ranges. At each of these levels, there is astounding beauty, and I can strongly recommend that anyone truly interested in plants take the time to examine several books on morphology and cytology. At the level of the whole plant, there is R. V. Cole's *The Artistic Anatomy of Trees.* In increasing order of detail and magnification (and difficulty), I would suggest: *The Structure of Life,* by R. Clowes; *Plant Diversity,* by R. N. Harris; *The Plant Cell,* by W. A. Jensen; *The Microstructure of Cells,* by S. W. Hurry; *Functional Organelles,* by J. H. Morrison.

Even a casual look at a landscape will show that plants are intimately interdependent with interactions between the environment and plants and animals. These topics, included under the general heading of Ecology, or Environmental Botany, have particular impact in today's world, where the alteration of a bit of land by a footpath or a road may have repercussions that shake the houses of Congress. It was not by chance that the irreplaceable art collection of Florence was almost ruined, for the flood was a direct result of inexcusable alterations of the vegetable environment in the hills around the city. Marston Bates has written a basic, highly readable book, *The Forest and the Sea,* which will serve to break you into environmental patterns of thought. Peter Farb's *Ecology* is, like others in the "Life Nature Library," a beautifully illustrated and very readable introduction. From these, the interested reader can go to *This Great and Wide Sea: An Introduction to Marine Biology,* by R. E. Coker, and to *The World of the Forest,* by H. E. Clepper and A. Meyer. Peter Farb's *The Forest* and W. D. Billings' *Plants and the Ecosystem* cover much of the same ground in more detailed fashion. For the adventurous, advanced reader I would recommend *Biogeography: The Distribution of Animals and Plants,* by W. T. Niel, and J. H. Storer's *The Web of Life*—another lovely title for a book.

In addition to the direct application of economic botany to man's well-being, books on plant utilization frequently make good reading. Norman Taylor's *Narcotics: Nature's Dangerous Gifts* and F. L. Fitzpatrick's *Our Plant Resources* are two of many good books. A third very useful primer is H. G. Baker's *Plants and Civilization,* but it was designed for college reading and is less sprightly than is Taylor's book.

Most people accept evolutionary theory without thinking about it—"Ah yes, Darwin." If there are two cultures, as C. P. Snow said (and I am not sure that his thesis has more than book sale value), it would be in the presumed failure of the educated non-biologists (note that I didn't say non-scientists) to understand current concepts of evolution. Yet these concepts are neither obscure nor difficult to grasp. There is a plethora of fine books on the topic, and I will note just a few of the ones that fit into this reading program. Start at the beginning with either *How Life Began,* by I. Adler, or *The Evolution of Life,* by F. H. T. Rhodes. Darwin's *The Origin of Species* is available in paperback for 95¢ and should be purchased if only to indicate that you have an intellectual home; social culture could scarcely be less expensive. From here, I suggest J. M. Savage's *Evolution* or *Understanding Evolution,* by H. H. Ross. For a rough but rewarding reading experience I suggest *Processes of Organic Evolution,* by G. L. Stebbins. Incidentally, the book by Lady Nora Barlow, *Charles Darwin and the Voyage of the Beagle,* is fun to read.

I will only mention a few books on genetics, primarily because the subject is too big for a portion of an article. Nevertheless, important things are happening here and much of what is going on will affect the thinking of plant science. In sequence, read Charlotte Auerbach's *The Science of Genetics,* R. P. Levine's *Genetics,* and J. D. Watson's *Molecular Biology of the Gene.* None are easy reading, and all should be taken in reasonable doses—like medicine.

I know that it is dirty pool, but since I am a plant physiologist, I have left this subject for the end of my article. If pressed hard enough, I will admit that there are other areas of botany with their own real fascinations and intellectual excitements. Yet I know—deep down inside—that no other area of science is half as much fun as is physiology. Plants metabolize, grow, make many compounds, absorb water and nutrients from the soil, carry on photosynthesis, react to stimuli, and do many other things. Each of these activities has necessarily become the province of a specialized group of plant physiologists, and each has accumulated enough solid information to warrant at least one book on the subtopic. Again, the over-all view is best as a start. *The Life of the Green Plant,* by A. W. Galston; *The Living Plant,* by P. M. Ray; and *Plants at Work,* by F. C. Steward, will give you three somewhat

different views of the area of plant physiology. From this base, one can move in several different directions. For plant growth and development, I think that *The Growth of Plants*, by G. E. Fogg; *Development in Flowering Plants*, by J. G. Torrey; and *Vascular Plants: Form and Function*, by F. B. Salisbury and R. V. Parke, make a well-rounded set. In metabolism and biochemistry I recommend H. Street's *Plant Metabolism* and J. A. V. Butler's *Inside the Living Cell.* As yet, there is no really good book on photosynthesis, although J. L. Rosenberg's *Photosynthesis* can be used. This is not a criticism of the book—the field has moved very rapidly since this book was published. For the advanced reader there is *A Metabolic Basis of Physiology*, by A. Schrift.

It is difficult to stop. Obviously, there are many more books both in paperback and hard cover that I know should have been listed. I can only suggest that you discover some of them for yourself. I assure you that the finding and the reading will be pleasurable. More books are coming out in all areas of plant science as professional scientists become aware of their responsibility to include the layman in the intellectual excitement that modern botany engenders. The Natural History Press is readying the "Plant Science Series" of paperbound volumes on botany designed for this very purpose, and other publishers are also active in this field. One final point, don't neglect the secondhand bookstalls; many of the old books are charming and informative.

Richard M. Klein, Professor of Botany at the University of Vermont, specializes in plant physiology.

THE GREENLAND ICE CAP, by Børge Fristrup, translated by David Stoner. *University of Washington Press, $20; 312 pp., illus.*

This is a Danish book written by a Danish glaciologist who has an intimate knowledge of Greenland and its icecap. Many of us in the Western Hemisphere have a tendency to forget that Greenland is a Danish possession; perhaps the reason for this tendency is the magnanimous attitude of the Danes in opening this unique piece of property to international scientific efforts. Greenland is the largest island in the world; it contains the only true ice sheet in the Northern Hemisphere; and this ice sheet comprises about 12 per cent of the land-based ice of the earth, some 665,000 square miles, with an average thickness of about 5,000 feet, enough ice to raise the level of the world ocean 21 feet if it melted.

Dr. Fristrup begins his account with a summary of the general characteristics and dimensions of the Greenland icecap, pointing out immediately, here as well as many times later in the text, that there is a good deal of uncertainty in measurements of size and position in this wilderness area. Then we go with him on a tour of the periphery of the icecap from Kap Farvel (Cape Farewell) in the extreme south to the unglaciated Peary Land in the north and back again.

Throughout this book the author demonstrates that he is not only a worthy glaciologist but also a talented historian. After a brief account of the activities of the Norsemen about A.D. 1000, he moves through the earlier periods of investigations of the icecap.

The period 1850 to 1888 saw the first scientific work carried out on the icecap; it was a time in which the explorers were looking for oases in the central regions of the island, since they could not imagine a sheet of ice large enough to cover so large a country. At the end of this period, Fridtjof Nansen made the first crossing of the icecap.

Nearly one hundred pages, or approximately one-third of the book, are devoted to detailed accounts of modern investigations, those during and since the Second World War. French, British, and American scientists led this attack in co-operation and collaboration with Danish and other Scandinavian scientists. The author tells us not only about the scientific results but also about life on the icecap. Drawings and descriptions show the tremendous evolution of man's adaptation to the special living conditions encountered on and in the ice. The first construction for wintering-over in the central part of the icecap was a tent surrounded by an igloo, the whole of which was rapidly buried by snow during the course of the winter. There, A. Courtauld survived the winter of 1920/21 completely alone, running out of paraffin for cooking and light well before his relief team came to dig him out. Only the air vent projected above the snow surface. Such an experience is in great contrast to the modern American radar installations, called Dye stations, built on stilts above the ice surface in order to avoid the eternal problem of drifting snow, and in which life "is very much like that on a large ocean liner."

The final six chapters constitute a short course in glaciology, and they are written on the level of the intelligent lay reader. The climate, thickness, movement, age, and regimen of the ice sheet are each treated in some detail; and the author ends with a description, hypothetical but nevertheless very probable, of the way in which the ice sheet first formed. Fristrup gives us not only the results of the most modern investigations (through the summer of 1965) but also elaborates the methods employed, such as gravimetric and seismic studies. He goes into some detail on the mechanism of glacier flow, Glen's flow law for polycrystalline ice, and the role of a basal layer of meltwater in ice movement. The author demonstrates his intimate knowledge of these methods and the results, as well as of the men who are currently the "big names" in glaciology.

This book has no peer. Even in the rigorously scientific literature there is no one source to which one can turn to find such a complete account of the description, history, and scientific findings concerning the Greenland icecap. There is a long bibliography for those who would like to go further into these subjects, but Fristrup's book is so complete that it is likely that only specialists will need more detailed information. It is to Denmark's credit that a Dane of international standing in glaciology has written such a fine work.

WILLIAM R. FARRAND
The University of Michigan

ART OF THE KWAKIUTL INDIANS AND OTHER NORTHWEST COAST TRIBES, by Audrey Hawthorn. *University of Washington Press, $25.00; 410 pp., illus.*

One of the world's great art traditions, and perhaps the most spectacular art style of the North American Indian, was that developed by the native tribes of the Northwest Coast. These peoples, dwelling on the shores of the brooding rain forest that stretches from Puget Sound northward into Alaska, created wood carvings and other esthetic works of such distinction that today collectors vie with a passion for possession of the limited number of pieces remaining outside of museums. Except for the cave paintings of Upper Paleolithic Europe, no other art of a population lacking the "civilized" increments of agriculture or animal husbandry seems to have evoked the admiration of the Western world as much as that of the Northwest Coast Indians.

Yet this is an art that, in spite of its importance, has been utterly inadequately studied by the methods of field anthropology. This is not entirely the anthropologists' fault, for the heyday of Northwest Coast art occurred in the eighteenth and nineteenth centuries, before the development of modern cultural anthropology. Furthermore, many of the outstanding wood carvings, especially masks, were created as an integral part of religious and shamanistic mysteries whose secrets were often guarded from fellow tribesmen, not to mention inquiring white ethnologists. Nonetheless, in this book,

which focuses on the art of the Kwakiutl, Audrey Hawthorn has shown that even at this late date new and useful information can be obtained on Northwest Coast Indian art and artists.

Mrs. Hawthorn took the step, which one hopes other anthropologists will emulate, of encouraging elderly Indian informants to study the collections at the Museum of Anthropology of the University of British Columbia, where she is curator. As she notes:

"We had facilities for making tea and coffee in the workrooms, and on many afternoons an old [Kwakiutl] couple sat with their grandchildren in the midst of the bustle and turmoil of work going on around them, drinking

Kwakiutl Tokwit crab from Gilford Island.

tea and looking at the things still on the storeroom shelves, and then offering reminiscences and anecdotes with the humor and wistfulness a time now distant evoked for them."

The results she achieved are highly important. Through careful interviewing and cross-checking between informants, Mrs. Hawthorn was gradually able to learn the names of the individual Kwakiutl artists who had created many of the important carvings in the collections. Since some of these carvers had made several of the pieces, it became possible to discern individual differences in style between artists of the same tribe. Thus, now for the Kwakiutl, one can speak of the "Willie Seaweed" style, presumably with as much confidence as one can distinguish a Cézanne in our own culture. This evokes the suspicion that the lack of creative vitality that some art historians and critics have attributed to tribal arts in the non-Western world is primarily a function of the anonymity of the individual artists involved, and this anonymity itself has partially been a result of the ethnocentrism of field collectors who have failed to inquire as to the identity of the individual creator.

Hawthorn also provides us with insight into Kwakiutl responses to their tribal art during visits to the museum:

"Some have noted the crudity of carving and painting of certain masks and showed some indignation and contempt for poor craftsmen. They seemed to feel that it was a reflection on the seriousness of the occasion for which the masks had been made. They appreciated the better pieces and were frequently able to identify the carvers. Not all Kwakiutl have been artists, however, nor are they all art critics. Some were apparently indifferent to the esthetic qualities of the masks, being concerned only with the questions of who had owned them and when they had been worn."

The basic orientation of Hawthorn's book, however, is not toward studying individual esthetic variation among the Kwakiutl, but toward providing an illustrated catalogue of the Northwest Coast pieces at the University of British Columbia. Since the Kwakiutl are the best-represented tribe in the collections, their work also dominates the book. Other tribal peoples of the region whose artistic products are included are the Salish, Nootka, Bella Coola, Haida, Tsimshian, and Tlingit.

What is particularly unusual about the publication is that the author has chosen to illustrate it with photographs of all the ceremonial pieces in the university's Northwest Coast collections, regardless of their artistic merit. This is a welcome and anthropologically much more valid practice than that of the normal museum exhibition catalogues, which tend to focus on the more "beautiful" specimens. However, such thoroughness has a price, and in this case it will have to be paid by the purchaser of the book. For the connoisseur, I will note that there are thirty-two full-color pages of some of the most dramatic pieces, including outstanding examples of the Kwakiutl Cannibal Society bird masks of which Mrs. Hawthorn's museum probably has the world's best collection. Altogether over one thousand specimens are illustrated by photographs, accompanied by texts providing general cultural background and specific information on the ceremonial arts of the Kwakiutl and their neighbors. There are maps, a glossary, and an index.

MICHAEL HARNER
Columbia University

Briefly Noted

BIRDS OF THE ANTARCTIC, by Edward Wilson, edited by Brian Roberts. *Humanities Press, $17.50; 191 pp., illus.*

That Edward Wilson, a member of Scott's Antarctic expedition, had a genius for detailed recording in illustration is evident from the remarkable array of his paintings and sketches of Antarctic birds. But it was his genius for detail in recording places and events in his journals and letters that makes this volume more than just another handsome collection of bird paintings. For anyone who wants to share the rigors of painting, collecting, and observing birds in subzero

temperatures—this book is highly recommended.

TRACKS, by E.A.R. Ennion and N. Tinbergen. *Oxford University Press, $4.25; 63 pp., illus.*

An artful collection of photographs (by Professor Tinbergen) of tracks left by birds, mammals, amphibians, and insects, occasionally "enlivened" with drawings (by Dr. Ennion) of the animals that made them. The activities of the animals at the time the tracks were made are deduced, in an almost Sherlock Holmes manner, from small signs likely to be overlooked by the ordinary observer. The authors have provided a fascinating addition to the annals of nature detection.

DESERT SOLITAIRE, by Edward Abbey. *McGraw-Hill Book Co., $5.95; 269 pp., illus.*

"Not imitation but evocation" of the desert world is Mr. Abbey's goal. But this book is much more than the poetic reflections of a park ranger in Arches National Monument. The author throws some well-aimed and not-so-poetic punches at the Park Service, the Department of the Interior, the U.S. government, and the motorized tourists "sealed in their metallic shells like molluscs on wheels" as he laments the disappearance of yet another national area under the welter of paved roads, Coke machines, parking lots, and motels. As Mr. Abbey says: "This is not a travel guide but an elegy."

THOSE OF THE FOREST, by Wallace Byron Grange. *Arno Press, $7.95; 314 pp., illus.*

Published originally in 1953, this natural history classic is part of The Abercrombie & Fitch Library, which will, according to its prospectus, make available "excellent" books on sport, adventure, and wildlife that have been allowed to go out of print. Centered around the snowshoe rabbit, this book is a poetic evocation of the life cycle of an animal and the broader interrelationships of all plants and animals. Olaus Murie's original woodcuts have, happily, been retained in this edition.

C. B.

This list details the photographer or other source of illustrations, by page.

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60—Topsell, *The Historie of Foure-footed Beasts*
61—Field Museum of Natural History
71—U. of Wash. Press

Letters to the Editor

San Francisco Bay

Malvina Reynolds' "A Song of San Francisco Bay" in your January, 1968, issue gives a welcome description of the problems facing San Francisco Bay.

The Army Corps of Engineers has estimated that two-thirds of the bay is shallow enough to be filled for the purpose of real estate development. But this would transform this spectacular natural resource into a river. destroying its beauty. limiting its use. and creating a great loss to the public.

We urge all citizens to write to Governor Reagan urging his administration to establish permanent controls to protect San Francisco Bay. an irreplaceable *water* resource. Trees can grow back, land can be redeveloped, but once filled, the bay is gone forever.

MRS. CLARK KERR
Vice President
Save San Francisco Bay Association
Berkeley, California

National Parks

I would like to commend NATURAL HISTORY magazine for one of the more substantial critiques of current national park problems. But reading Jack Hope's thoughtful. if irreverent, treatise on the fluctuating distance between the national parks and heaven confirmed a conclusion I reached some time ago: writers on the subject of national park conservation live in the best of all possible worlds: the Director of the Park Service lives in this one.

Certainly the sensational accounts that have recently appeared in so many newspapers and magazines picture a different Yosemite Valley from the one I know. I wholly agree that critical problems exist in Yosemite, but those who picture the valley as an urban slum, in my view, forfeit their credentials as objective reporters. Were I by nature suspicious I would almost believe that many of these chroniclers of chaos, like the writers of TV westerns. do their research entirely from the stories of their colleagues.

And I detect a remoteness from reality in the reprimand awarded Secretary of the Interior Udall for his so-called dislike of fighting with the lumber interests over the Redwoods National Park controversy. Such a gratuitous estimate might be regarded as being as much an evaluation of the writer's political maturity as an assessment of Mr. Udall's zest for conservation battles—examples of which are not particularly hard to find. When Mr. Hope asks "whether the National Park System can survive prosperity," I would agree that he is, as they say, getting to the gut issue. For, as he points out, an expanding economy creates a mobile population that heads in ever greater numbers for the national parks.

Perhaps those of us who work every day attempting to develop viable answers to Mr. Hope's question overestimate the complexity of our task. I admire the ease with which some of our conservation colleagues arrive at solutions to such problems as limiting the numbers of park visitors—to quote from a recent critic: "Simple, install a reservation system."

Well, that's not quite like "Let 'em eat cake," but it's close.

Critical articles such as this one are essential when they do help develop a dialogue between an informed public and those who administer the national parks. But if critics are truly interested in achieving solutions. why do they not stand up to be counted when public resentment descends upon the Director of the National Park Service for making the decisions they have called for?

When Director Hartzog recently announced the end of the traditional Yosemite firefall, long the focus of criticism by conservationists as a carnival activity, the following expression in a California newspaper was typical of the hundreds received: "I hope that nature lovers everywhere will write their U.S. Congressmen and U.S. Senators letters of protest that will push each glowing ember from Glacier Point under this bureaucrat's seat as Director of the National Park Service, Washington, D.C., so that he will be forced to rescind his 'silly little millimeter' ruling which, unfortunately, so drastically affects all lovers of God's great outdoors."

The national parks are indeed faced today with all the vexing frustrations of affluence. Ironically enough, a decade or so ago. during the pre-Mission 66 days of park poverty, Bernard de Voto wrote his milestone *Harper's* article, "Let's Close the National Parks."

One is almost tempted to match Mr. Hope's irreverence and say, "Yes, Charlie Brown. in good times or bad, it's hard to be a winning park administrator."

WILLIAM C. EVERHART
Assistant Director, Interpretation
National Park Service
Washington, D.C.

It is a shame that the ideas contained in Jack Hope's excellent article "Prosperity and the National Parks" [February, 1968] cannot be communicated

to more people through other media. Unfortunately, the most common media for reaching the public in this country seem to be preoccupied with different priorities.

Mr. Hope raises some basic questions about pressures on the national parks—pressures that arise, as he suggests, not only from the sheer numbers of people visiting the parks, but more importantly, from the attitudes and values of these people.

When the number of park visitors becomes more important than the quality of any particular experience, the visitor begins to see less and less as he hurries to do more and more. All of which is not unlike listening to a 33 1/3 r.p.m. recording of the Beatles' "Sgt. Pepper's Lonely Hearts Club Band" or a Mozart quintet run at 45 r.p.m. The argument, of course, is that one "gets through" more quickly and has more time for other things—whatever these other things may be.

The question that must be raised ultimately is whether the Beatles, or Mozart, or, even more pertinently, the national parks are really for everyone.

This suggestion is in no way intended to provoke a discussion of democracy and attendant abstractions such as equal opportunity. My contention simply is that a vast number of Americans who go to parks do so without any real understanding of what a park is or what the so-called park experience involves. I also believe that if more people were clear about these questions a great number of them would realize that the type of experience they seek is not provided in the national parks, and might therefore pursue their interests elsewhere.

Parks suffer from a blurred image. This is partly a result of a hazy concept held by many visitors who expect the parks to provide some form of entertainment and active recreation—which, in the recent past, has included boating, movies, music, and even magicians. It is also the result of the many roles the Park Service plays, all in the same costume. Historic sites, wilderness areas, national parks, recreation areas, and more, all become a confused blend of responsibilities for the Park Service and create a fuzzy picture for the visitor. "If you can swim and boat in that park, why can't you do it here?" Essentially, this is a problem in communication and definition.

Perhaps this confusion raises the question of whether the responsibility for the development and management of recreational areas, a most important job, should lie in the same hands that are responsible for creating a public awareness and understanding of unique natural areas. These, it seems, are very separate tasks.

Many problems of communication

between the National Park Service and the public lie within the territory of the National Park Service's Interpretive Division—particularly with the rangers who meet the public in the field. In essence, these men must become the eyes and ears through which the visitor comes to understand the park experience; they must interpret a language that is almost forgotten in many urban areas—the language of field and woodland, winter and spring, glacier and volcano. Ideally, these men, who are responsible for leading the visitor to a qualitative experience within the parks, should also serve to create a deeper appreciation of the environment outside of the park, in the world in which the park visitor lives.

While we are a long way from an ideal communication between the National Park Service and the public, noteworthy changes are taking place that are the result of sensitive and intelligent reflection by the top administrators of the Park Service. George Hartzog, the Director of the Service, deserves considerable credit for initiating this reappraisal. It is his considered judgment that led to the termination of the showy, but nevertheless meaningless, Yosemite firefall. Along with it will go the professional entertainers, the magicians and musicians, that have come to characterize Camp Curry in Yosemite Valley. I am sure Mr. Hope would welcome these changes. This action clearly demonstrates that the National Park Service, not the commercial concessionaires in the parks, has the responsibility for defining park purpose and use.

Mr. Hartzog has received considerable protest and criticism for taking these steps. He deserves far better than this, for his decision was not an easy one, although it unquestionably is in the best interests of the whole of the National Park System. My dealings with the Park Service lead me to believe that these changes at Yosemite reflect the beginning of a major rethinking of the concept of national parks—a move for which the Park Service deserves considerable credit.

There is no question that articles such as Mr. Hope's and the attitudes expressed by private conservation groups and individuals have an important function. They not only provide a productive interchange of ideas but they provide external guidelines by which those people entrusted with the responsibility for our national parks can more clearly assess their own goals. Perhaps in this sense and this sense *only*, parks are for everyone.

William H. Eddy, Jr.
Conservation Foundation
Washington, D.C.

Suggested Additional Reading

BUGS AND BEASTS BEFORE THE LAW

THE CRIMINAL PROSECUTION AND CAPITAL PUNISHMENT OF ANIMALS. E. P. Evans. Heinemann, London, 1906.

THE TRIAL OF ANIMALS AND INSECTS. H. L. Carson. *American Philosophical Society Proceedings*, Vol. 56, p. 410, 1917.

INSIDE THE TORNADO

THE NATURE OF VIOLENT STORMS. L. J. Battan. Doubleday & Co., Garden City, 1961.

TORNADOES OF THE UNITED STATES. S. D. Flora. University of Oklahoma Press, Norman, 1958.

THE MIGHTY WHIRLWIND. D. Wagler. Pathway Publishing Corp., Aylmer, Ontario, 1966.

THE FEAST

PEOPLE OF THE RAIN-FORESTS. G. Seitz. Heinemann, London, 1963.

RED CLOTH AND GREEN FOREST. A. Vinci. Hutchinson, London, 1959.

THE ESTHETICS OF ORCHID POLLINATION

ORCHID FLOWERS—THEIR POLLINATION AND EVOLUTION. L. Van der Pijl and C. H. Dodson. University of Miami Press, Miami, 1966.

FERTILIZATION OF ORCHIDS. C. Darwin. D. Appletton and Company, New York, 1877.

AN INTRODUCTION TO THE BEHAVIOUR OF INVERTEBRATES. J. D. Carthy. George Allen and Unwin, London, 1958.

THERE REALLY IS A ROADRUNNER

DESERT ANIMALS: PHYSIOLOGICAL PROBLEMS OF HEAT AND WATER. K. Schmidt-Nielsen. Oxford University Press, New York, 1964.

THE ROADRUNNER IN FACT AND FOLKLORE. J. F. Dobie. *Bulletin of the Texas Ornithological Society*, No. 4, pp. 1-14, 1956.

TEMPERATURE REGULATION AND EVAPORATION IN THE PIGEON AND ROADRUNNER. W. A. Calder and K. Schmidt-Nielsen. *American Journal of Physiology*, Vol. 253, No. 4, October, 1967.

BIOLOGY AND COMPARATIVE PHYSIOLOGY OF BIRDS, Vols. I and II. A. J. Marshall, ed. Academic Press, New York, 1961.

MEANDERS OF THE GIRAFFE THROUGH ART AND HISTORY

THE GIRAFFE IN HISTORY AND ART. B. Laufer. Field Museum of Natural History, Chicago, 1928.

ARTISTS OF THE ROCKS. W. Battiss. Red Fawn Press, Pretoria, 1948.

THE BOOK OF BEASTS. T. H. White. Johnathan Cape, London, 1954.

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Natural History

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Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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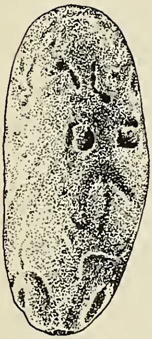

DEPARTMENTS

Publication Office: The American Museum of Natural History, Central Park West at 79th Str New York, N.Y. 10024. Published monthly, October through May: bimonthly June to Septem Subscription: $7.00 a year. In Canada and all other countries: $7.50 a year. Single copies $.70. Second-class postage paid at New York, N.Y., and at additional offices.

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Paul R. Ehrlich

Louis Dupree

John D. Palmer

C. Loring Brace

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William K. Hartmann

THE AUTHORS

PAUL R. EHRLICH joined the faculty of Stanford University in California in 1959 and is now Professor of Biology and Curator of Entomological Collections. He received his graduate degrees from the University of Kansas. Ehrlich has devoted a great part of his research to the study of natural populations and the theoretical aspects of population biology as a whole. Much of this work has been carried out at Stanford's Jasper Ridge Biological Experimental Area and at the Rocky Mountain Biological Laboratory near Crested Butte, Colorado. In addition, he has conducted field work in many areas including Mexico, Alaska, Canada, Africa, and Australia.

The University of Chicago's Center for Middle Eastern Studies chose LOUIS DUPREE to present its Public Lecture Series this month. In the group of seven lectures he is attempting to present a total picture of Afghanistan, its land and its people. Dr. Dupree says that he became interested in Asia while serving as a merchant seaman and paratrooper during World War II. After the war he attended Harvard University, receiving his doctorate in 1955. In addition to being a member of the American Universities Field Staff, Dr. Dupree is an Adjunct Professor of Anthropology at Pennsylvania State University and a Research Associate of The American Museum of Natural History. He has conducted research not only in anthropology but in geology, geography, and zoology as well. In several trips, he has spent a total of some six years in Afghanistan and is at present writing a general book on that country for the Princeton University Press.

JOHN D. PALMER's earlier NATURAL HISTORY articles on the migratory habits of *Euglena* (February, 1967) and the geomagnetic aspects of animal orientation (November, 1967) reflect the nature of his professional work in the field of biology. This month, however, he has written about one of his hobbies—wine making. Dr. Palmer has studied the chemistry of wine making for several years and makes his own wine at his New Rochelle, New York, home. During 1963 and 1964 Palmer st ied at the University of Bristol, E land, as a National Science Foun tion Fellow. He earned his doctor at Northwestern University and now Associate Professor of Biol at New York University.

C. LORING BRACE is Curator Physical Anthropology at the U versity of Michigan's Museum Anthropology. He has been trai both in geology and anthropol and received the Ph.D. from Harv University in 1962. Since that ti Dr. Brace has devoted much of time to a reappraisal of the Neand thal question and, in connection w his research, has conducted fi work in France and Yugoslavia. is author of the 1967 Prentice-H book entitled *The Stages of Hum Evolution.* This coming summer Brace plans to do intensive field w in Africa.

JEROME H. WOOLPY received Ph.D. last year from the Univers of Chicago and is presently Assist Professor of Biology at Earlh College in Richmond, Indiana. Woolpy feels that his studies of captive wolf population at the Bro field Zoo, conducted over a per of nine years with Drs. George R and Benson Ginsburg, have ne such valuable information ab animal behavior that he hopes ot zoos will initiate similar animal search programs. He has written lectured on a wide range of subje including cockroaches, orangut and, especially, wolves. Woolp presently studying the genetics development of aggression in rabl

Pennsylvania-born WILLIAM HARTMANN received his B.S. in p ics from Pennsylvania State Uni sity, then attended the Universit Arizona where he studied geol and astronomy, earning his Ph.D 1966. He is presently an Assis Professor of Astronomy at the versity's Lunar and Planetary l oratory. In 1964-65 Hartmann w co-winner of the Nininger Mete Award. Hartmann's investigatio craters, such as Keonehehee Mauna Kea in Hawaii, in which shown standing in the pictur left, has taken him over a large of this planet's surface.

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The Coming Famine

I read Arthur Hopcraft's *Born to Hunger* while flying to Washington to address the Second International Conference on the War on Hunger. I could not help but be impressed with the contrast between the hopelessness, malnutrition, failure, and death described in his compelling narrative, and the air-conditioned, overfed opulence of the first-class section of our 707. A day later, in our nation's capital, I was impressed by another contrast. First I had the pleasure of meeting William C. Paddock, coauthor of the tough-minded *Famine 1975!* Then I sat through a long day of speeches at the conference, many of which were compounded of wishful thinking and political platitudes —albeit given in support of what the participants thought was a good cause. The conference was, in essence, a political rally for the Food for Peace Act.

If there is a "war on hunger," then Hopcraft's book is a report from the front. On a 45,000-mile trip through Africa, Asia, and South America he recorded his personal impressions of what it is like to be on the losing side. He tells of Dr. Lema's survey of the vicinity of Dar es Salaam, which listed 30 per cent of the children under five as malnourished. From this area 65 children entered the hospital suffering from severe kwashiorkor, a disease caused by malnutrition, and 14 of them died. Farther to the west, in a less fertile region, the death rate of children under five is nearly 50 per cent. The situation is similar in India. Hopcraft quotes Dr. Shah of Ajarpura, India, to the effect that in the Ajarpura area the infant mortality rate of 125 per 1,000 births was caused by gastroenteritis, respiratory diseases, and malnutrition. And Ajarpura was considered a progressive village, although the majority of the people were malnourished.

In Colombia, Hopcraft reports 100 infant deaths per day from malnutrition, and in Turkana, Kenya, he reports 6,000 people still living on handouts in famine camps established in 1961. But his reporting is not just of hunger and malnutrition in the underdeveloped world. He deals with a vast maze of related subjects: agriculture, agricultural training, urbanization, public health, cultural attitudes toward food, communications, and, above all, the root cause of the entire problem—overpopulation. *Born to Hunger* does not deal with most of these systematically, but rather area by area in an informal travelogue style. And in this lies the great strength of the book, for it gives immediacy to the problem; it makes you feel you are there. It would serve as a wonderful treatment for those stunned by the statistical avalanche that inevitably buries whoever seeks to understand the plight of the underdeveloped world. Hopcraft finishes his book with a rather good discussion of the need for population control—especially effective in pointing out that even the most optimistic demographic predictions make a strong case for tight population control. His short chapters on "aid" are somewhat marred by the optimistic view that the developed world has all of the means to help the underdeveloped out of its predicament. I wish it were true, but I am afraid it is not. Especially in the area of tropical agriculture we lack expertise that could have been developed over the past few decades had the need been widely recognized. But this flaw is slight, and *Born to Hunger* can be

recommended as a good piece of reporting.

Famine 1975! would make in esting reading after *Born to Hun* William and Paul Paddock have w ten a book of strategy for mini ing our losses in the war on hun They claim that massive famines now inevitable, and that the Un States cannot hope to feed all of hungry. The essence of the Paddo

American grain elevators—
an illusion of plenty.

tegy is to reserve our food aid those nations it will help the most. Paddocks say we can't save yone from starving, so we must ide where our limited food sups can do the most good. They sug-, for instance, that sending more l to India, as will be done under Food for Peace Act, is a waste. y say we cannot prevent massive ines there, and that our limited food can be put to better use helping countries that have a chance of becoming self-sufficient. It is not a point of view designed to please Indian or American politicians, who have reacted strongly to it.

Whether or not the Paddocks are right is a matter of great debate. The

by Paul R. Ehrlich

Indian Government, for instance, claims that the country will be self-sufficient agriculturally by 1971, barring further droughts. Knowledgeable people doubt it (biologists may remember that the same government claims malaria has been eradicated —news which has not yet reached the plasmodia!). For instance, Louis H. Bean, international economic consultant, told the War on Hunger Conference that he expects the present gap between Indian food production and population will widen over the next decade. Another expert, Dr. Raymond Ewell, recently summed up his view of the Indian food situation in an address to the Synthetic Organic Chemical Manufacturers Association. He stated:

"In 13 years India is going to add 200 million more people to their population. In my opinion, as an old India hand, I don't see how they can possibly feed 200 million more people by 1980. They could if they had the time, say until the year 2000. Maybe they could even do it by 1990, but they can't do it by 1980. It's a matter of time, of learning new techniques and doing all the various things that need to be done. They all take time.

"Even the United States would be greatly pressed to provide for 200 million more people. Say we had 200 million more people dumped on the United States in 13 years. We'd have an extremely difficult time feeding them alone, to say nothing of providing housing and education and transportation, parking spaces for all the cars, etc. It would be an enormous problem for the United States, and yet the United States has a superb industrial plant, very productive agriculture, a good educational sys-

tem, excellent natural resources, lots of natural gas, petroleum, coal, mineral ores of all types. India has none of these things. And yet India is going to have 200 million more people in the next 13 years."

Difficult as it is to make sense of the vast "numbers game" of population–agriculture statistics, my guess is that the Paddocks' assessment of the situation is the most accurate. But then, concerned biologists recently have been tending more and more toward a new version of Pascal's wager. Pascal said that the best strategy was to believe in God. If there was one, you were saved. If there wasn't, you lost nothing. Similarly, believing in the Paddocks' predictions can only help us. Everyone admits that more than half of the world is undernourished, with many starving. We clearly already have too many people—what conceivable reason can there be for further increasing the population? People such as Karl Sax have been warning of the consequences of overpopulation for decades. Their views were widely contested by the technological optimists and the superstitious. Now we know that Sax and others were right. But the same kinds of people who opposed Sax and population control before, now condemn the Paddocks. They want to focus their attention on producing more food, perhaps giving lip service to population control. Or if, like the Indian Government, they finally have committed themselves to population control—perhaps too late or ineffectually—they want well-intentioned efforts to be considered successes. Few people, inside this country or out, want to face the cold, hard facts.

These facts are really quite simple, and only three in number. The first is that, by the elementary standard that most people are going hungry, the world today is overpopulated. And we expect the situation to get worse. At present the population of the world is growing at a rate of slightly less than 2 per cent a year. Doubling times (the time required for the population to double) range from about 20 to 30 years in the underdeveloped countries. In the developed world, countries mostly lie in the 50- to 120-year range—with the United States one of the fastest (about 63). Some demographers see reason to hope for a substantial reduction in population growth rates in the last quarter of the century. But even those more optimistic than I, such as my colleague Dudley Kirk, are pessimistic about the short run. And I admit to extreme pessimism about population control with the current level of effort. Reports from India are not very cheering—low level acceptance of vasectomy, rejection of the intra-uterine device (IUD's), removal of IUD's in order to collect again the small monetary reward paid by the government for insertion. Bernard Nossiter (*Washington Post*, March 7, 1968) gives a very depressing report of the failure thus far of the birth control campaign in rural India. The following sample statements will give the flavor of the article:

"They are afraid that the sterilizing operation will destroy their male power and make them docile, like castrated animals. Mostly, they are afraid of interfering with God's will."

"A Hindu father of three blurts out 'It is a sin to prevent children from being born.' "

"A grizzled farmer breaks in angrily and says 'You must practice self-control.' "

"Nagoan's crew is responsible for 59,000 persons in more than 100 villages. In the 10 months of active campaigning only 47 vasectomies have been performed, 27 loops inserted and very few free condoms accepted."

Unhappily the establishment in the developed world is mesmerized with the concept of "family planning"—an approach that has so far been a failure in the area of population control. This failure has been brilliantly outlined by Kingsley Davis (*Science*, November 10, 1967). As he says "the things that make family planning acceptable are the very things that make it ineffective for population control. By stressing the right of parents to have the number of children they want, it evades the basic question of population policy, which is how to give societies the number of children they need. By offering only the means for couples to control fertility it neglects the means for societies to do so." Justin Blackwelder of the Population Crisis Committee put it differently in a recent letter: "Family planning means, among other things, that if we are going to multiply like rabbits, we should do it on purpose. One couple may plan

ıe Hasselblad System...
ıd why a certain kind of person might fall in love with it.

re are many people who buy use a car just to get from ıt A to point B, and who buy piece of mechanical equip- ıt strictly on the basis of it orming a particular func- with the minimum of in- ement on their part.

this kind of person there is ertain kind of camera, the that does all the thinking nim. Film is loaded in the of a cartridge, a button is sed...and that's all; total involvement.

don't misunderstand us, re not criticizing either the on or the camera. They will probably be very happy each other...But, there is her kind of person. The who buys a fine automobile, ust to get from point A to B, but also for the great ure he gets from actually ng it. For this kind of per- here is also a certain kind mera...the Hasselblad... nera that doesn't do all the ing for you.

Hasselblad is a camera for ind of person who buys a of mechanical equipment, ıst to perform a particular ion, but also for other, st intangible, reasons. For eel, the look, the touch, times even the smell of it. nly he could give you very l, logical reasons for buy- and probably spending more money than he pay for the simpler, non- ing "push-button" model, one of these would be the easons.

eal reason is very simple— in love with it. Many men a very few lucky women) love with a beautiful ma- To these men, there is thing about a piece of ment that not only looks, els good and performs its on better, because it's ed and built better than ng else in the world

And that's what the Hasselblad is. The best designed and built camera in the world.

Many people have bought a Hasselblad after just holding one in their hands for a couple of minutes. They seem to know instinctively that it will take great photographs. And, if even further proof is needed, not only has a Hasselblad been carried on every NASA space flight, but more top professional photographers use Hasselblad than any other camera in the world.

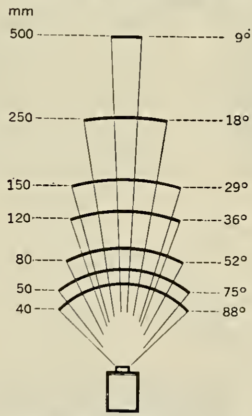
The basic Hasselblad camera is really just part of a completely integrated and interchangeable system of camera bodies, film magazines, lenses and accessories.

The film format used in the Hasselblad System is 2¼" square. This has been described as the "ideal" format, and with good reason. It's big enough to give you pictures of superb quality and definition, and yet small enough to allow the design and physical shape of the camera to be as compact as it is.

The Hasselblad uses the single lens reflex viewing system. The beauty of this method is that you see the object you are going to photograph on a large 2¼" square ground glass viewing screen, as you look through the actual lens that will take the picture, so you always know exactly how your finished picture will turn out.

There are three bodies in the Hasselblad System, each one designed and constructed to perform its own particular function better than any other camera of its type.

Firstly, the 500C. This could almost be called the "workhorse" of the Hasselblad System. It is the standard body in the System and takes all the lenses and magazines that are available for the Hasselblad. No single camera has been used and praised more by the top professional and amateur photographers than the 500C. The other two bodies are more "special purpose" cameras. The 500EL, which is an electrically driven camera allowing for rapid exposures and remote control, and the Superwide C wide angle camera. No other camera using the 2¼" square format has as wide an angle of view as the Superwide C. On its introduction, this camera was hailed as a breakthrough in camera design. There are seven lenses



Interchangeable Lenses. This diagram illustrates the focal length (l.) and the angle of view (r.) of the seven lenses available in the Hasselblad System.

in the Hasselblad System, all by Carl Zeiss, makers of superb quality optical glass for generations. The lenses range from a 40mm wide angle, to a 500mm telephoto. Every lens has a built in Synchro Compur shutter with provision for flash and strobe synchronization at all 10 shutter speeds, from 1/500 of a second to 1 second.

One of the most striking features of the Hasselblad System is the interchangeable film magazines, each one of superb design and construction. The beauty of these magazines is that with just one camera body, a photographer can shoot pictures in black and white. Then, before finishing the roll, change to a magazine loaded with color, shoot a few color shots, then go back to black and white film. One magazine even allows you to make 70 exposures on one roll of film. Hasselblad was the first camera system to offer the advantage of interchangeable magazines.

There are many many accessories in the Hasselblad System, each one designed and built to the same extreme standards of quality and craftsmanship that Hasselblad has become famous for.

Shown below are just a few items in the System.

Like all good things in life, the Hasselblad is expensive, but if you're the kind of person we have been talking about (and you wouldn't have read this far if you weren't) then, who knows, with this kind of camera, perhaps you could live on love alone.

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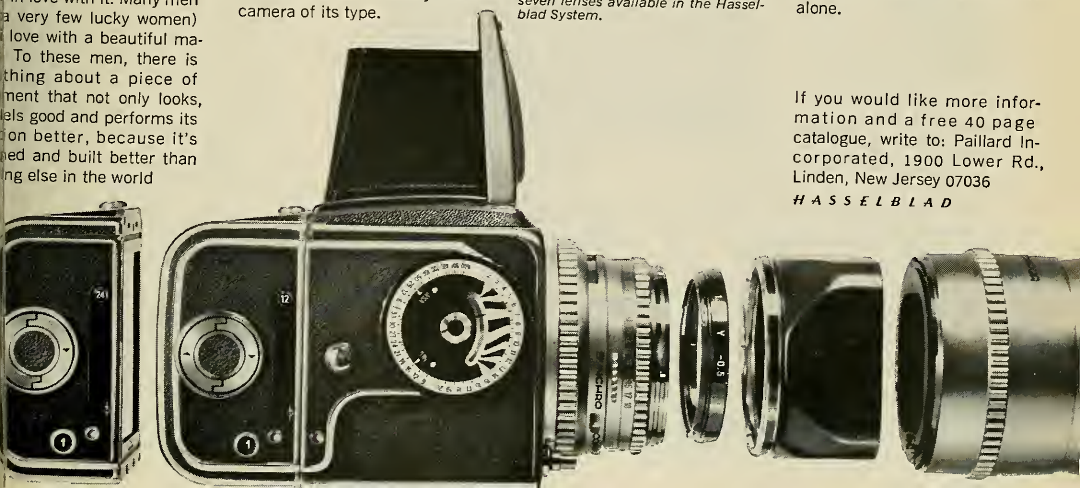

have three children; another coupl
may plan seven. In both cases the
are a cause of the population prol
lem – not a solution to it."

People in the underdeveloped area
of the world *want* large families-
sizes that promote demographic ca
tastrophe. "Family planning" is use
mostly to lock the barn door after th
horse is stolen. For instance, Davi
reports that of 5,196 women seekin
assistance in rural Punjab, India
two-thirds were over thirty. Sinc
many were married before they wei
fifteen it is hardly surprising tha
more than half of them already ha
six or more children. Conservativ
groups, such as the Committee o
Population of the National Academ
of Sciences, cling to the idea tha
family planning programs fost
their own further acceptance. It
too bad for the world that wishin
won't make it so! Their commenta
on Davis' fine article, which the Cor
mittee on Population published
Science (February 23, 1968) mak
instructive reading for those co
cerned with reasons for the lack
effective population control measur
in the world today. This committ
states that a "zero rate of populatic
growth may be essential in the lo
run, but as a goal within the tin
horizon of current policy it has litt
support in either the developing
the developed world, certainly n
among governments." What a pi
that the committee does not use i
prominent position to attempt
change governmental goals.

So the first fact is that there a
too many people, and more arrivi
every day. The second is that fo
supplies are inadequate. Even mo
optimistic food "experts" think th
agricultural production will at be
be enough to maintain today's stan
ard of misery over the next decac
Many informed people believe th
a monster food–population gap w
appear in the next decade, and th
massive starvation will occur. Mo
of the "hope" in the line of food pr
duction comes from two areas. T
first is the hope of a good harv
this year—potentially an extraor
narily good one because of supe
weather. If this hope is met when t
harvests are in, then the world w
pretty much be back where it was b
fore the 1965-66 disaster years.
second cause for limited optimism
the spreading and acceptance of n
varieties of rice, wheat, grain s

ghum, and corn. These are being rushed into production, but their actual potential under field conditions and over the long term is largely unproved. We can only hope. And if we are intelligent, we will base our plans on somewhat less than optimal results.

Finally, and even more critical, is a fact not discussed by the vast maority of writers on the population–ood problem, including Hopcraft and the Paddocks. That is, we are rapidly destroying our planet as a habitat for *Homo sapiens*. The warnngs of eminent ecologists such as Lamont Cole continue to fall on deaf ears. The War on Hunger Conference vas started with a filmed Esso comnercial promoting the use of oil, asphalt, and pesticides for short-range productivity gains with no consideraion of long-term environmental conequences. While technological optinists dream of more pesticides, ertilizers, and farming the sea, the cologically sophisticated are conerned about the poisoning of the ea, the air, and the soil. They are oncerned about chronic poisoning f people by pesticides, and the oisoning of children by nitrates (from fertilizers) in baby food. They re concerned about the reduction of hotosynthesis on land and in the sea eading to a serious reduction in the xygen in our atmosphere. They are oncerned about the possibly fatal inerruptions of delicately balanced cological cycles. They are concerned bout hundreds of unplanned acts espoiling our environment. They re concerned that an insane preocupation with an ever growing gross ational product could lead in the ot-too-distant future to no national roduct at all.

It is quite possible that the penalty r frantic attempts to feed burgeong populations in the next decade ay be a lowering of the carrying apacity of the entire planet to a vel far below that of 1968. But, of ourse, too few people in the develoed world seem to care about the te of their less fortunate fellow pasngers on the spaceship Earth today. ass concern for future generations ems too much to ask.

Mankind may be facing its final isis. No action that we can take at is late date can prevent a great deal future misery from starvation and vironmental deterioration. The dinensions of the programs that must

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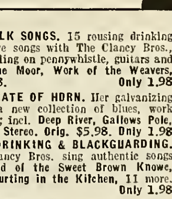

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be mounted if we are to survive are awe inspiring. To ameliorate the "time of famines" I have suggested that the developed world, through the United Nations, set up a multivalent program of area rehabilitation. This program would involve simultaneous population control, agricultural development, and, where resources permit, industrialization of selected countries or sections of countries. Population control would be the *sine qua non* of area rehabilitation, and careful consideration and monitoring of environmental consequences would be an absolute requirement. The program would involve the establishment of TV networks (with distribution of sets for communal viewing in villages) to help people understand population control, public health, and agricultural measures. It would include a worldwide renaissance of agricultural–ecological research and the promotion of a "county agent" network for the underdeveloped world.

If we can get population growth halted without unprecedented catastrophe, then we must turn to the question of the "carrying capacity" of the earth, although this is a question that we can begin to consider now. What is an optimum population size, from the point of view of man's physical and psychological welfare? What is the maximum level of material affluence that can be supported worldwide for an indefinite period of time without destroying the earth? No doubt this will prove to be a considerably lower level than Americans are accustomed to. Perhaps the concept of "the good life" needs re-evaluation, with less emphasis on material things. There is some evidence today that college students are less concerned with affluence than are their parents. The earth's energy budget and resources are limited. We must recognize that and learn to live within them. But changes in the quality of life for people can only be achieved when their quantity is under control.

Are the necessary programs possible? Possible, yes, but their realization seems hardly probable. Much will depend on whether the United States, as the most influential superpower, can be made aware of its grave danger. Can Americans learn the grim lesson that considering the population explosion a problem of the underdeveloped world is like saying to a fellow passenger, "your end

of the boat is sinking"? Most of our citizens do not realize, for instance, how totally we depend on imports for our material affluence. After all, we use well over half of all the raw materials consumed each year. Think of it! Less than 1/15 of the population of the earth requires more than all the rest to maintain its inflated position.

Many Americans may be willing to help the rest of the world for humanitarian reasons. Can other Americans be convinced that to help is in their own selfish interest? We are willing to spend many billions for ill-advised military–political interventions. Is it conceivable that this power can be diverted into projects of greater use to ourselves and the rest of mankind?

Unfortunately our government has its attention focused elsewhere, and is not aware of the true gravity of the situation. The likelihood seems nil that tens of billions of dollars a year will be spent to meet a threat most politicians cannot perceive. Could the biological community sound the warning and force the politicians to face reality? Unhappily, most biologists are involved in biomedical research leading to lowered death rates. They do not have the background, and often lack the inclination, to recognize the threat. And, of course, the degree of change in national attitudes and policies required to meet this challenge would be viewed as a threat to their position. After all, to save future generations we might have to change our pattern of research support! The answer will not come from the scientific and political establishment. The establishment must be forced into action by the concerned public.

The "concerned public" is already large, and will soon be drastically increased in size as riots tear cities apart, fishermen find they can no longer eat their pesticide-loaded catches, smog disasters become common, famine pre-empts the headlines, and the international situation continues to deteriorate. Everything possible must be done to mobilize American public opinion and to mobilize it fast. If the connection between growing population at home and abroad and the steady deterioration of the quality of life can be made apparent, then perhaps successful action can be instituted before our planet is irreversibly ruined.

A Naturalist at Large

Aliens in the Landscap

by Marston Bates

Look at those starlings. I haven't come across anyone who could be called a friend of the starlings. In the case of pigeons, people can be divided into pro- and anti-factions (with janitors solidly antipigeon), but the prostarling group is either completely absent or very quiet. A great deal of ingenuity has gone into the problem of discouraging starlings: gunfire and other noises, electric shock, playing recordings of starling alarm calls, and most recently, a never-drying sticky substance, which seems to work because the birds don't like to get their feet gummed up.

Yet in the last century quite a number of people thought it would be nice to have starlings in this country, and several attempts were made to get them established—unsuccessful until 1890 when about 80 pairs were released in New York's Central Park. The first starlings to breed here may well have done so under the eaves of The American Museum of Natural History—although the museum cannot be blamed for the introduction. The effort to establish starlings is the more puzzling because the birds had already proved to be pests when introduced into New Zealand and Australia, and they had never been admired by British farmers. But people set on bringing in some new species of plant or animal are not easily discouraged. Man has been influencing biogeography for quite a while now.

Of course many introductions are accidental rather than purposeful. Microbes, insects, and weed seeds are particularly apt to accompany man on his travels. Among mammals, rats and mice have done quite well; a number of lizards have become widely spread around the tropics by hitchhiking on ships. The uninvite travelers are likely to be pests—abou half of the major insect pests of crop in the United States are aliens, acc dentally introduced—and this has le to the establishment of quarantine to prevent their entry.

"Quarantine" comes from the Ita ian *quaranta*, referring to the fort day period of isolation imposed on ship—cargo, passengers, and crew— there were indications of unusu disease. The practice is said to hav started in fourteenth-century Venic long before there was any scientif basis for the action. Since Paste and the acceptance of the ger theory of disease, quarantines hav been elaborated and systematize but in many cases it is still possib to debate whether the restrictions a worth all the trouble they cause.

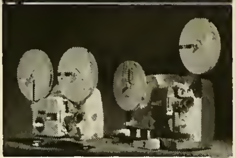
We are particularly sensitive abo introducing new insects, as anyo knows who has tried to carry fruit plants across a frontier. I am still n sure whether such quarantine ba riers are effective enough to warra the inconvenience—a doubt that I i herited from my father-in-law, Dav Fairchild. He was head of the Offi of Seed and Plant Introduction of t Department of Agriculture for ma years, and dedicated his life to mo ing possibly useful or ornamen plants around the globe. His gol friend for many years was Char Marlatt, chief of the Bureau of En mology. The friendship was ba strained when Marlatt established insect quarantine—and spoiled ma of Fairchild's plants by fumigatio

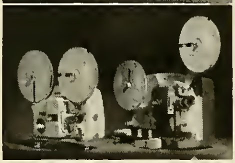
Fairchild argued that the quar tine was useless because it would be possible to carry out a thorou enough inspection to eliminate ll potential pests. He once tried to pr

his point at the border of California —a state that is particularly careful about alien insects and the foodstuffs on which they are likely to travel—by insisting that if they were going to inspect the car before permitting it o enter California, they should be horough about it. He got the inspec- ors to drag out and open all the suit- ases and go through the automobile arefully as tempers became strained nd traffic accumulated on the road ehind. He drove on, feeling smug bout the whole affair. Presently his vife reached into the pocket on the ar door to get a handkerchief—and ulled out an orange!

The various plant quarantine serv- ces usually publish statistics on the umber of thousands of insects that re intercepted every year. There are, f course, no figures on the number hat they fail to find, and some major ests have become established de- pite quarantine. The Dutch elm dis- ase is an example, although this is omplicated since both native and oreign bark beetles and a fungus are volved. The fungus, according to harles Elton in his book *The Ecol- gy of Invasions*, was first identified Ohio in 1930 and is thought to ave entered with infected elm timber sed for veneers. Elton discusses everal other pests that have been in- oduced "in spite of heavy screens f quarantine."

That alien species are not easily tablished in a new country is shown the history of attempts at deliber- e introduction. There were at least ve or six efforts to establish those arlings in the United States before e success of 1890. Goodness knows w many attempts have been made establish other birds in this coun- y: among them are several species





of thrushes, finches, and titmice, as well as the nightingale, wood lark, British robin, and mute swan. At one time it looked as though the goldfinch and skylark had become established, but they died out. Only six wild species of alien birds can be called successful: the Hungarian partridge, the ring-necked pheasant, the starling, the house sparrow, the European tree sparrow (in Missouri), and the Chinese spotted dove (in the vicinity of Los Angeles). (I regard pigeons as escaped cultigens.)

Europeans living in New Zealand and Hawaii have been particularly addicted to introducing birds and mammals for reasons of sentiment or sport. One would think it would be relatively easy to establish aliens in these islands—especially since both regions had rather limited bird faunas and no mammals except bats. But G. M. Thompson, in his book *The Naturalization of Animals and Plants in New Zealand*, reported that of 130 attempts to introduce bird species, only 24 succeeded. George Munro, in *Birds of Hawaii*, reports efforts to introduce 96 species, of which 19 have become well established, while 12 more seem likely to succeed.

There is considerable discussion as to whether the alien birds in Hawaii constitute a threat to the native perching birds—the peculiar thrushes and honeycreepers. Certainly the native birds are in a bad way: Munro estimates that 25 species have a fair chance of survival, while 30 others are either already extinct or likely to become so. Hawaii, however, illustrates a general phenomenon: that aliens are inclined to be most abundant in the man-altered landscape. This is probably because birds that are easily established are kinds that get along well with man—witness those starlings. Extinction of many local animals in all parts of the world is apt to be the consequence of multiplying human numbers, of man's activity in clearing and cultivating land, destroying the natural habitats. The survivors, except for the inhabitants of nature reserves, are what I have called the opportunists—the species that thrive in the human ecosystem.

I first became aware of this peculiarity of our associates some years ago when I was in a part of the upper Orinoco drainage in South America where man had had no detectable role

in altering the landscape. The plants and animals I had thought of as common—weeds, roadside birds, and butterflies—had disappeared or were found only in such natural open habitats as river sandbars. The organisms associated with civilized or agricultural man are a very special lot. One theory is that many of them were saved from extinction by man coming along just in time, that they would not have survived in undisturbed biological communities. Those animals and plants around us that look so tough are really the weaklings of the biosphere.

I suspect, then, that the extraordinary Hawaiian family of honeycreepers would be disappearing at just about the same rate if man had never brought any alien birds to the islands. On the other hand, if man should disappear from these islands, most of his associates might disappear too. Unfortunately, "most" is not "all." Quite a few of the man-moved aliens in various parts of the world would undoubtedly get along very well without him, to the detriment of the native biota.

It is interesting that many of the fresh-water fishes that man has moved thrive in environments that appear unaltered by human action. This is particularly true of such predatory species as the brown trout, the rainbow trout, and the large-mouthed black bass. In many places where these were introduced there were no native competitors—the case, for instance, in New Zealand, Tasmania, and isolated mountain lakes in many parts of the world—so that the success of the introduction is understandable. The trout, however, have also flourished in lakes where the local fauna seemed complete and well balanced. This is true in the South American Lake Titicaca, where rainbow trout have almost eliminated the indigenous fishes. This might be justified from the narrow human point of view if rainbow trout were considered better food; but in the case of Lake Titicaca the local people preferred their own fishes, and a thriving industry has been destroyed for the benefit of a few sportsmen.

The success of fishes is not limited to these larger predators—look at the teeming carp in many lakes and streams in the United States. The small topminnow of our southeastern states, *Gambusia affinis*, has been spread widely throughout the world in attempts to control malaria, since the fish has an insatiable appetite for mosquito larvae. It now teems in the marshes and ponds of southern Europe, North Africa, South Africa, Southeast Asia, and parts of South America. I know of no studies, however, of the impact of this species on native faunas. People worried about malaria have not worried about local fishes.

Other exceptions to the rule that man-moved aliens thrive best in man-altered landscapes are found among mammals, especially where these have been introduced into oceanic islands with few or no native species. The success of the mongoose in the West Indies and Hawaii is a fine example.

A Jamaican planter, W. Bancroft Espeut, imported four pairs of mongooses from Calcutta in 1872 for the purpose of controlling the rats that were causing great damage to the cane fields. The introduction was an immediate success, leading other cane-growing islands to try the experiment. But the success was short-lived; after a few years the rats in the cane fields became as abundant as ever. They had learned, it seemed, to nest high off the ground where the mongooses couldn't reach them. The mongooses then took to catching chickens and a wide variety of ground-living vertebrates—frogs, lizards, birds, small mammals. The mongoose itself came to be universally regarded as a pest.

Should we stop this practice of moving plants and animals around the world? The disasters have not convinced many wildlife officials. Sportsmen in the United States are still enthusiastically supporting the importation of game, and gardeners are not likely to stop trying new plants. The temptation is particularly great to try establishing the varied animals of the African grasslands in the southwestern United States and on the plains of Argentina. The case against moving animals around has been ably stated by George Laycock in a book called *The Alien Animals,* which also has an excellent bibliography on the subject of animal introductions. I think Laycock is right; but I also suspect that there is no chance that we will abandon this particular method of altering the landscapes in which we live. We should, at least, learn to be more careful than we have been in the past.

Radio Tracking

by L. David Mech

Have you ever wondered how large an area various animals cover in their normal travels? Or how often they return to certain locations within their range? These and related aspects of animal movements have long occupied the attention of biologists, and a great deal of research effort has been expended on them.

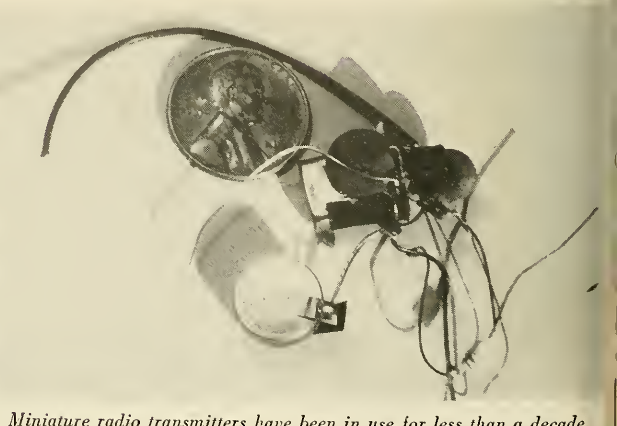
Until recently, the most usual means of studying the movements of vertebrates was the tagging-recapture technique. The scientist livetraps an animal, tags it, and releases it, hoping that some day he may recapture the creature and learn one more bit of information about its movements. In most cases, however, his chances of seeing a particular animal again are remote. Even if he does recapture it, he only learns where it has been in a few points of time and space.

Nevertheless, for many years the tagging-recapture technique was generally the best available for studying animal movements. To date, thousands of fishes, amphibians, reptiles, birds, and mammals have been tagged or banded with identifying numbers, and a certain amount of information about their movements has been gradually accumulated.

A few years ago a technique was devised that caused a tremendou surge both in the amount of infor mation obtained about animal move ments and in the degree of scientifi interest in this field. The techniqu involves animal telemetry and i known as radio tracking.

Basically the idea of radio track ing is simple. A radio transmitter i attached to an animal under study and from then on the signal emanat ing from the transmitter reveals th location of the animal. A researche with the proper radio receiver an directional antenna can determin the animal's approximate where abouts merely by triangulating o the signal, or by obtaining a singl bearing to the animal and then esti mating the distance on the basis o signal strength.

This technique could have bee used some forty years ago. However the weight of a transmitter produce at that time would have been so grea that only an elephant could hav carried it. Thus, generalized use o radio tracking had to await the tran sistor and the consequent age of elec tronic miniaturization, which no allows the manufacture of transmi ters light enough and small enoug to be carried by a 30-gram thrush.



Miniature radio transmitters have been in use for less than a decade.

The practical use of radio tracking also had to await just the right association of biologists and engineers. Various biologists had been thinking about the technique for several years but could not put their ideas into effect. No doubt many electronics engineers could have produced suitable transmitters, but they were not aware of the need for them.

By 1959, however, C. D. LeMunyan and a team of co-workers at Bethesda had developed a compact transmitter with a range of 25 yards, and the field use of radio tracking began. During the next year, at the University of Minnesota, W. H. Marshall reported on a transmitter having a range of 1.5 miles, and within three years he and his associates had used them effectively on porcupines and ruffed grouse. Meanwhile, W. W. Cochran working with R. D. Lord, Jr. in Illinois developed a transmitter with a similar range that weighed 10 grams and used only $8.00 worth of parts. The age of radio tracking had arrived.

In the few years that have elapsed since then, a high degree of sophistication has taken place in radio-tracking hardware and techniques.

Transmitters are now available that weigh only 2.5 grams, including the battery. Although such a transmitting system only has enough power to operate for two or three days, it has proved very useful in the study of bird migration. For research requiring a longer transmission life, heavier batteries can be used. Recently, new types of batteries have been developed that will provide much longer life for their weight. Thus "radio-collars" weighing 75 to 100 grams, including battery, transmitter, and attachment material, are now commonly used on animals the size of skunks and raccoons for periods of five to six months. Larger animals such as deer can be tracked for more than a year with a radio-collar just twice this weight. Rabbits, hares, and squirrels wearing 40-gram collars can be followed for up to three months.

Several types of receiving systems are also in use. The simplest is a portable, battery-operated receiver coupled to a small directional antenna, which can detect a signal from a distance of 1/4 to 2 miles. The entire system is hand-held and thus can be taken into the field to determine the

exact location of a resting animal, whether it is a hole in the ground, a hollow tree, or a surface bed. Such a system is useful in many kinds of animal-movement studies, and is the type commonly employed today. It is also used to supplement the more advanced receiving devices.

A modification of this system involves a vehicle with a revolving antenna that is connected to a receiver inside the vehicle. In areas with a dense network of roads, this receiving system works well in tracking most mammals, and it allows the researcher to follow several individuals during a short time period.

A more advanced version of this system was recently developed by W. W. Cochran, of the Illinois Natural History Survey, for bird-migration studies. These studies require that researchers wait patiently, day and night, for hours or even days before the radio-tagged bird departs. Then, when the bird suddenly begins its migration, a special alarm goes off inside the vehicle, waking or alerting the research team, who immediately take up pursuit and follow closely with the vehicle, keeping the antenna pointed toward the bird at all times. During the long, hectic pursuit of the migrating bird, another automatic device keeps the antenna following the bird's movements regardless of the vehicle's direction of travel.

Mobile receiving systems inside aircraft have also been used during bird-migration studies and are a prerequisite for following birds across large bodies of water. In addition, they are useful in tracking highly mobile mammals such as wolves.

An advanced type of receiving system that has worked well with the more sedentary birds and mammals involves semipermanent antennae mounted on masts. The stationary antennae can be elevated, thus allowing a considerable increase in range. The receiver for each antenna is situated inside a field station or trailer from which operators can comfortably track several animals.

The most sophisticated animal-tracking system yet devised is almost completely automatic. Once radio-tagged animals are released within range of this system, data on their locations—and in some cases their type of activity—are automatically recorded every 45 seconds on micro-

film. A technician then converts these data to a form usable by a computer. The computer calculates several movement parameters, compiles the data into frequency distributions, and directs an automatic plotter to map the animals' movements.

An apparatus of this type now in operation at the University of Minnesota can track as many as 52 individuals simultaneously. It uses two :ontinually revolving antennae permanently mounted on high towers, and can provide acceptable data on animals in an area of about 20 square niles. Such a sophisticated system is expensive to build and operate, but it provides a quality and quantity of lata commensurate with its expense.

Along different lines of sophistica-ion, a research team at the Uni-ersity of Washington developed a elemetry system that provides much nore information than just the lo-ation of an animal. This device was sed on free-ranging baboons in Kenya and was able to furnish data bout the pressure and rate of blood ow in these animals from a distance f two miles. At the same time, it llowed the researchers to anesthe-ze the subject animals from this istance. Whenever the team wanted) replace a baboon's batteries or re-over the animal's $5,000 telemetry ack, the scientists merely sent out signal to a special device the crea-ire was wearing. The signal acti-ated the device, which then anes-ietized the baboon.

With the variety of animal-track-ıg systems available today, almost ıy biologist can find one that will t his budget. Thus, biologists inter-ted in animal movements can now arn much more in the time ex-ended than they could have even ten ears ago.

In addition to increasing the ıantity of the information avail-ble, radio-tracking devices provide ore kinds of information than ere previously obtainable. The tag-ng-recapture method usually fur-shed only very gross data on an imal's range and minimum extent travel. With radio tracking, one n gather data about an animal's eed and patterns of travel, its tem-ral patterns of activity, its inter-tions with other animals, and the tensity with which it frequents rious parts of its range. In many ecies, one can determine from the

quality of the transmitter's signal whether an animal is resting or active at any time. With ruffed grouse, for instance, workers have even been able to tell when a bird is feeding or drumming.

Information can also be obtained on predation and on other mortality factors since radio-tagged animals can usually be found even when dead. In addition, growth and weight changes of subject animals can be checked periodically because these individuals can be located and recaptured more easily than ever before. Finally, radio tracking allows a biologist to readily locate the dens, nests, and resting sites of his study animals, which then can be further investigated in any number of ways, including direct observation of the animals.

Regarding the last-mentioned advantage, the words of Frank and John Craighead demonstrate the great value of radio tracking in their well-known studies of the grizzly: "In some 3,000 square miles of grizzly bear habitat, 85% heavily wooded, man and grizzly can arrange to meet, with the man alone aware of the grizzly's presence and location. He can observe undetected. This ability to locate, move in, or follow and then observe is in itself a tangible research reward."

Because of all the advantages of radio tracking, it probably should be considered the single most important technique ever developed in the study of vertebrate natural history and ecology. In less than ten years this technique has proved itself to be revolutionary. Published studies using radio tracking have destroyed certain old concepts about animal movements, have modified others, and have suggested any number of new hypotheses.

There are indications that within the next five or ten years further strides will be made in the radio-tracking technique. Thus one can expect the study of the movements and behavior of free-ranging vertebrates to progress at an even faster rate. At a time when most of man's technology is exerting destructive pressure upon the natural world, it is of some comfort to note that certain technical advances may be of benefit.

L. David Mech is a wildlife biologist, best known for his predation studies of wolves and moose.

The Oldest Sculptured Head?

by Louis Dupree

The recent discovery of a man's head sculptured on an oblong limestone pebble in an Upper Paleolithic level at Aq Kupruk, in north Afghanistan, represents the oldest known sculpture in Asia, and probably one of the oldest specimens to be found anywhere in the world.

Aq Kupruk is an archeological site on the Balkh River, in the limestone hills south of Mazar-i-Sharif. Extensive prehistoric remains were uncovered when, with a team of American and Afghan specialists, I excavated three rock shelters and an open-air site there between 1962 and 1965. The archeological sequence in the region extends from a two-phase Upper Paleolithic (20,000-15,000 B.C.), through a two-phase Non-Ceramic Neolithic (9000-5200 B.C.), to a Ceramic Neolithic (5000-4500 B.C.).

Until excavations at Aq Kupruk uncovered this sculptured head, the oldest Near Eastern stone sculptures were objects found at several Natufian sites in Palestine, which dated to the ninth millennium B.C. The only other sculptured head of comparable age (about 20,000 B.C.) was one sculptured from a mammoth's tusk at the Gravettian (Upper Aurignacian) site of Dolní Vestonice in Moravia, Czechoslovakia. This important site not only yielded ancient sculpture but also contained evidence of what might be the oldest man-made habitation structures, including what is probably the world's oldest kiln. The Vestonice head represents one of man's earliest attempts at three-dimensional artistic representation. Another sculptured ivory head, definitely female and possibly of Gravettian date, occurs at Brassempouy (Les Landes), France.

The limestone head from Aq Kupruk is the only human art object as yet identified in the Kuprukian Upper Paleolithic levels. However, the find is more accurately datable than most other portable art objects from western and eastern Europe since the majority of these were discovered before the development of radiocarbon dating methods. Most of the European objects—for example, the Vestonice finds—have been relatively dated, according to geologic and typological evidence. The Aq Kupruk object, however, predates an absolute carbon-14 determination of 14,665 ±215 B.C. made on a charcoal specimen from the Kuprukian B level by the West German dating laboratory Niedersächsisches Landesamt für Bodenforschung, Hannover. Kuprukian B overlies the older Kuprukian A level from which the sculptured head was taken. The A level probably dates to about 20,000 B.C.

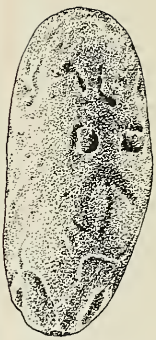
Both Kuprukian levels contain generally the same chert tool types, a total of over 20,000 worked implements, including both blades and microlithic artifacts. An extensive series of hearths also occurred in both levels. The sculptured head appeared in a Kuprukian A hearth, haphazardly surrounded by hundreds of chert tools. Probably the artist first outlined and engraved the facial features with a burin. Although the burin could easily have been the only tool used, the deepening and final shaping, particularly of the eyes, could have been executed by a chert perforator, gently tapped by a hammerstone or wooden hammer.

The perspective of the sculpture is as unique as its antiquity. The pebble's natural shape undoubtedly limited the artist, but the three-quarter frontal view, probably a singular example in Paleolithic art, gives the piece a Picassoesque flavor. Carving at the top represents either hair or maybe a skin cap; a beard and perhaps a moustache have been carved near the bottom. In addition, a roughly outlined right ear can be seen.

On the advice of several specialists, the sculpture has not been cleaned or the hardened sediments removed from the carved portions, because of the soft condition of the stone.

Does this work of art have a function, or is it the result of a man (or woman) simply doodling on a pebble with a burin? If the latter, it is strange the excavators found only one. Any attempt to speculate further would be more than gratuitous, but the location of the find in a hearth is interesting. Could black magic or voodoo have been involved? Such practices still exist in remote areas of Afghanistan.

We shall probably never know the non-material function of the ever growing inventory of prehistoric art discoveries and must simply be content to let objects like the Aq Kupruk sculpture turn us on or off esthetically as the case may be.



Actual size

Red Wine

The formation of wine from grapes is a *spontaneous* happening. That is, a single crushed grape left to destiny will miraculously transmute with time into wine. Measured by today's epicurean standards, this crude wine would be barely potable—still, it would be wine. To elaborate on the quality of the beverage, man has basically only two roles to play: he must obtain the best wine grapes available and then provide the most propitious conditions under which the wine can develop. When these two broad roles are fulfilled to perfection the resultant product is worth our most sincere obeisance.

Although fine wines from the eastern United States are now produced from the native grape species *Vitis labrusca,* most of the world's great wines are produced from a single grape species: *Vitis vinifera* ("wine-bearing vine"). Through centuries of selection this species has radiated into thousands of separate varieties, only thirty or so of which are capable of yielding outstanding wine. Each of these varieties grows best under particular climatic and soil conditions, and, as a result, we find the great French wine-producing areas each with their own best variety: the Pinot Noir in Burgundy, the Cabernet Sauvignon in Bordeaux, and the Syrah and Grenache of the Rhone Valley. Often the most exquisite wine grapes come from an area only a few acres square; for example, probably the greatest red wine vineyard in the world is the

The mechanics and chemistry of transforming the grape

150-acre Château Lafite-Rothschild.

Great wines are not made by great men, but from great grapes. Therefore let's examine the grapes in some detail. A grape is a large berry consisting of the skin, pulp, and the seeds, or pips. While the first two components produce the wine, the latter plays only a small role, and the wine maker conscientiously avoids crushing them, for they contain acrid substances and oils. In Spain, where the grapes are still often crushed by foot, the *pisadores*, as these men are called, wear heavy-soled boots studded with hobnails, which are so spaced that the pips are not broken by the treading.

The pulp of a ripe grape is a mass of large, thin-walled, turgid cells containing the virtually colorless juice. Grape juice is mostly water and sugar (averaging about 75 and 22 per cent, respectively) but it also contains organic acids, minerals, nitrogenous compounds, and vitamins. The importance of these latter components is greater than their quantity might indicate, because from them the finished wines receive much of the distinctive taste and bouquet that are largely responsible for the charm of individual wines.

by
JOHN D. PALMER

The sugars are primarily glucose and fructose, which tend to be present in equal amounts. Both compounds have the same chemical formula, $C_6H_{12}O_6$ (meaning that each molecule has 6 carbon atoms, 12 hydrogen atoms, and 6 oxygen atoms). However, the atoms are arranged differently within each molecule, and so their chemical properties are slightly different. Fructose, for example, tastes almost twice as sweet as glucose. During fermentation these sugars are converted to alcohol.

Malic and tartaric are the most abundant organic acids in grapes. They are synthesized in the leaves and then translocated to the developing fruit in July and August. The acids in the finished wine produce the agreeable tartness of the beverage. Too little acid and the wine is flat and unappetizing. The nitrogenous components and vitamins are not particularly important to the wine itself, but are mainly used as growth factors by yeast.

Within the grape skins are the pigments (which color the wine) and tannins. The main pigment substances in red wine grapes are called anthocyanins and are widely distributed among the flowering plants, where they are responsible for nearly all of the red, mauve, and blue plant colors. Tannins—substances that can be used to tan animal hides in the formation of leather—are responsible for the agreeable astringency of the finished wine, that is, they cause a dry, puckery sensation in the mouth. This is a sought-after quality in red table wine, and its absence leads to insipidity.

The outer surface of the grape skin is naturally waxy, and this layer supports a visible, powdery veneer (the bloom) of fungi. The bloom is a microcosm of molds, rots, and yeasts.

At harvest, wine grapes contain the levels of sugar and acid necessary for fermentation. A whitish layer of fungi (the bloom) visible on the grape surface, below, furnishes yeasts for the fermentation process.

The yeasts, tiny soil-dwelling organisms, can withstand the cold of northern winters by remaining dormant, and are blown onto the grapes during the following growing season. These one-celled plants are responsible for the fermentation of grape sugars into alcohol.

The harvest is performed when the desired proportion of acids and sugars is attained in the grape. Cool climates, such as in northern Europe and the northeastern part of the United States, produce grapes with more coloring matter in their skins and a high acid content. Warm, dry climates, as in much of California, produce grapes with a low acid content but a higher concentration of sugar. As grapes ripen, the sugar content increases and the acidity decreases. Therefore, in warm regions the vintner must pick his grapes before the sugar content is too high and the acidity has fallen too low. Conversely, the wine maker in cooler northern regions must wait until just before the first frost to obtain sufficient sugar content. The harvest may be as early as mid-July in the Mediterranean wine-growing regions, and mid-November in Germany and Alsace.

Once the grapes have reached optimum maturity, they are harvested and transported to the winery where they are crushed and placed into fermenting tanks. The outmoded method of tramping underfoot has now been mostly replaced by mechanical crushers, which burst the grape skins and free the pulp and juice without breaking the pips. In the making of red wines, the entire contents of the crusher—juice, pulp, skin, and pips—go into the fermenting vat. In the case of white wine, the juice is pressed out of the grapes and sent alone to the fermentor.

The pulp, juice, skins, and pips—collectively called the must in wine maker parlance—are now ready to begin fermentation. However, the desirable yeast cells of the bloom,

which ferment the grape sugars to ethyl alcohol, are greatly outnumbered by undesirable organisms, and care must be taken to insure that the good yeasts get the upper hand and the undesirable fungi and bacteria are suppressed.

The standard way of insuring this is by bubbling sulphur dioxide through the must (sulphiting). This acrid gas is a selective disinfectant capable of retarding or killing the bad ferments while only temporarily stunning the good ones. Following this process, a "yeast starter"—a pure culture of true wine yeast—is added to insure that any bad ferments still remaining are held at bay.

Yeasts are not demanding in their nutrient requirements. Only sugar, a few nitrogenous substances, some minerals, and a small supply of vitamins are needed. All these are present in the must. The yeasts obtain their energy source from the sugar. They take it into their bodies and, when oxygen is available, break it down to water and carbon dioxide. However, when yeasts are living deep in the fermenting vat, which is largely devoid of oxygen, the sugar is broken down into carbon dioxide and ethyl alcohol. The simplified reaction of this anaerobic process is:

$$\underset{\text{(sugar)}}{C_6H_{12}O_6} \xrightarrow[\text{yeast action}]{} \underset{\text{(ethyl alcohol)}}{2C_2H_5OH} + \underset{\text{(carbon dioxide)}}{2CO_2} + \text{energy}$$

The energy is used by the yeast cell in metabolic processes concerned with building protoplasm and sustaining life. The alcohol and carbon dioxide are unusable waste products and are excreted out of the yeast cells into the must. Carbon dioxide is a colorless, odorless gas that escapes from the must as tiny, coalescent bubbles. Ethyl alcohol is a colorless, volatile intoxicating agent that remains dissolved in the must. Also present are a collection of alcoholic substances called fusel oils, which account for less than 0.04 per cent of the wine but which are disproportionately important since they are responsible for certain characteristic flavors and bouquets.

Grape must is a very favorable home for the yeast cell, which may duplicate itself as often as once every hour or two. As the yeast cells propagate, the over-all fermentation rate of the must is increased. Twenty-four hours after sulphiting, the vat is already gently bubbling. As the process gathers force, bubbles become trapped in the grape skins, causing them to rise to the surface. Soon a floating island of skins appears, which may extend several feet above the fermentation vat; this is called the chapeau, or hat.

Originally it was thought that the fermentation of grape sugar proceeded according to a single chemical reaction and was catalyzed by a single yeast enzyme called zymase. Many treatises on wine making still mention this enzyme as the single substance that gives us the gift of wine. Modern chemistry has shown, however, that zymase does not exist and that fermentation consists of a series of no less than sixteen reactions, each with its own enzyme. In the production of wine, yeasts undergo the same series of complicated fermentation reactions as occur in bread baking. The main difference between bread baking and wine making is that in the former, man capitalizes on the carbon dioxide (which is trapped in the bread dough, causing it to rise), and deems the alcohol an incidental by-product. When bread is baked, the heat of the oven kills the yeast, causes the bubbles of trapped carbon dioxide to expand so the bread rises again, and drives off all the alcohol present. It is the escaping alcohol that is mostly responsible for the savory aroma of baking bread—a fact that might startle some teetotaling housewives.

The carbon dioxide produced in fermentation is also used in making beer and sparkling wines—sparkling burgundy and champagne. Sparkling wines are produced by adding a predetermined amount of sugar and yeast to the bottled wine after primary fermentation is completed. The bottle is then sealed with a wired-on cork and fermentation starts again, liberating a small quantity of alcohol and carbon dioxide. The latter is unable to escape from the bottle and remains dissolved in the wine, reaching a final pressure of about 6 atmospheres. When the bottle is opened, exposing the wine to normal atmospheric pressure, the carbon dioxide comes out of solution and escapes as thousands of ebullient bubbles.

In producing non-sparkling, or "still," table wines, the primary fermentation process gradually slows down as the concentration of alcohol builds up and inhibits the yeasts. When the alcohol concentration reaches about 14 to 15 per cent, fermentation stops even if there is still plenty of sugar remaining for the yeast. If one wants a sweet dessert wine, the residual sugar is a desirable leftover. But sweetness is an undesirable quality in red table wines, so a grape must with not more than 28 per cent sugar can be used; otherwise unfermented sugar will remain. On the other hand, since fermentation converts about half of the sugar into alcohol, the sugar content of the must should be more than 17 per cent, for a finished wine with only 8.5 per cent ethyl alcohol is hardly palatable and will not keep well.

Accumulation of alcohol in the must also causes the death and disruption of the cells in the grape skins, liberating their pigments and tannins into the juice. It is therefore necessary to keep the skins in contact with the alcohol as much as possible, and to insure this, the chapeau is punched down into the wine at least twice a day. Rosé wines are made by fermenting the wine with the skins for only 24 hours, thereby releasing only a small portion of the skin substances, which produces a light pink wine that is light in flavor.

Primary fermentation may last anywhere from a few days to a few weeks. At its conclusion the must is transferred to a press where the juice (now properly called wine) is separated from the marc—the skins, seeds, and other solid material. After pressing, it is transferred to white oak barrels where the harsh young wine begins to undergo the thousands of chemical reactions that change it into a delicious mature product.

Shortly after the original fermentation, the wine will start to ferment again, provided the temperature of the storage area is high enough. In

unheated storage areas, the secondary fermentation may be delayed until the following spring. This fermentation is called malolactic fermentation and is not due to yeast activity, but instead to malolactic bacteria, which convert malic acid to lactic acid:

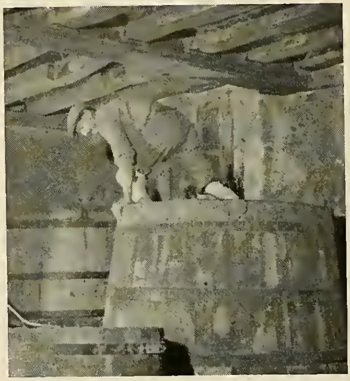
$$\underset{\text{(malic acid)}}{C_4H_6O_5} \xrightarrow{\text{bacterial action}} \underset{\text{(lactic acid)}}{C_3H_6O_3} + \underset{\text{(carbon dioxide)}}{CO_2}$$

Wines with a high malic acid content taste harsh, green, and tart; it is therefore quite important for them to undergo malolactic fermentation, because lactic acid (the acid of sour milk) is considerably less sour. Because carbon dioxide is a by-product of the process. the wine again begins to bubble, but never with the same eruptive vigor of primary fermentation. At the end of secondary fermentation, the wine will have softened in taste and changed in odor.

Wines produced in northern climates have a high malic acid content. and malolactic fermentation is therefore a requisite for good wine. In the warmer wine-growing regions such as central and southern California, however, the rapidly maturing grapes have a low malic acid content to begin with, and since a small amount of malic acid is necessary in wine, malolactic fermentation is undesirable. Therefore, sulphur dioxide is added to these wines to prevent the initiation of secondary fermentation.

During secondary fermentation, and from now on, it is absolutely necessary to isolate the wine from contact with oxygen. To do this, a fermentation bung is used to stopper the barrels: this simple device allows carbon dioxide to escape from the barrel but prevents oxygen from entering. At the finish of secondary fermentation the barrels are completely filled and a standard solid bung driven home. Periodically, the barrels are opened and additional wine is added to replace that which has evaporated. thus eliminating the dangerous oxygen-containing air space in the barrel.

If the wine is allowed to come into contact with oxygen for any extended period of time, the results may be disastrous. for living within the wine are acetic acid bacteria (*Acetobacter*) that, in the presence



Grapes are crushed prior to fermentation. Two older meth are shown above and at left: using a small hand press and tramping underfoot. During fermentation, the sugar conten is sampled, below left. After fermentation, wine is decanted into barrels, right, where suspended particles settle. Before bottling, wine is aged, preferably in oak casks. Below right, a vintner notes the progress of aging.

of oxygen, grow and oxidize the ethyl alcohol to acetic acid. If acetification has taken place, this becomes poignantly obvious by smelling the wine; the characteristic symptom of this malady is the smell of acetic acid, the acid of vinegar. In fact, this is the way wine vinegar is made commercially; the word comes directly from the French *vin aigre,* sour wine.

Once fermentation has subsided, aging begins. Materials previously held in suspension by the churning action of the escaping carbon dioxide gradually settle out. This sediment, or lees, is composed of skin fragments, pulp, dead and inactive yeast cells, cream of tartar crystals (which sometimes coalesce to form "wine stones"), and other solid substances "thrown off" from the maturing wines. Cream of tartar is a white solid formed when tartaric acid combines with potassium dissolved in the wine. Since cream of tartar is more soluble in warm aqueous solutions than in cool ones, the vintner sometimes chills his wine before bottling it to make sure that all of the cream of tartar will precipitate. Otherwise—and this is more true of white wines—cream of tartar may settle out in the bottle causing an undesirable cloudiness known as gravel to winemen.

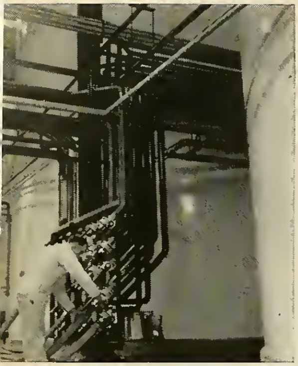
About four to six weeks after the secondary fermentation has stopped, the wine is racked—carefully decanted off its lees into a clean barrel. As the wine continues to mature, further chemical changes occur and more particles settle out; therefore, a red wine is racked about four times within the first year of its life. Racking is traditionally done around the time of full moon. This is not superstitious folklore, however, for the weather is usually clear at this time of month and the barometric pressure high. If wines are racked when the barometric pressure is low, dissolved gases in the wine tend to escape on opening the barrel, roiling up the light lees so that complete separation of wine from sediment-deposit is not accomplished.

A healthy red wine will usually become clear and brilliant of its own accord, but sometimes a suspension of colloidal material remains. Colloidal matter consists of minute particles, all of which possess the same electrical charge. Because like charges repel each other, every colloidal particle repulses its neighbor; this material remains in suspension until the introduction of a fining agent, which combines with the particles and causes them to settle out. Isinglass (a translucent gelatin obtained from the swim bladders of sturgeons) was the traditional fining substance used for good wines; however, white of egg, clay, casein (the principal protein of milk), fresh blood, and gelatin are also used. Instead of fining their wines, some wineries filter them, which is a much more rapid process.

Aging red wines in oak cooperage is important for at least two reasons. First, the porosity of the wood allows oxygen to slowly diffuse in, and mix with, the wine. Oxygen in small quantities will not stimulate the initiation of acetification. As the wine breathes through the barrel, many series of oxidative reactions refine the character of the wine considerably. Oxygen also enters the wine through the porous cork after it is bottled. These oxidative reactions are not well understood at present and may remain inscrutable forever—precluding the chance of ever writing the chemical formula for a perfect wine. The barrel is also important as an additional source of tannins and other substances, which are extracted by the wine and add to its longevity and character.

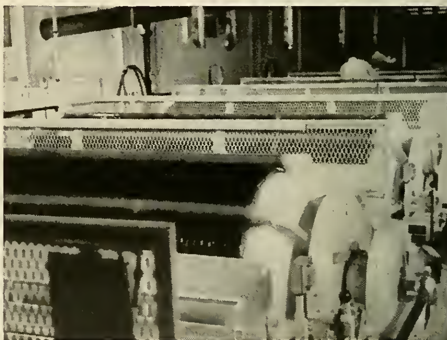
Another consequence of aging is the formation of volatile esters—substances produced by the combination of organic acids with an alcohol. Esters are common in the living world where they are responsible for the fragrance of flowers and fruit, and are used as sex attractants by many animals. In wines they provide component odors to the complex bouquet.

The rate of the oxidative reactions and other chemical changes that take place during aging is a direct function of temperature: the higher the temperature the faster the reaction. In fact, the rate about doubles with every 18°F. rise in temperature. Therefore, the benefit of aging at high temperatures is obvious: a wine



could be made ready for consumption in a fraction of the time. However, high-temperature aging is not practical for red wines because many of the aging products are volatile and are driven out of the wine by this treatment. Red table wines are best aged at between 55° and 65°F.

The wine, now ready for bottling and further aging, is a very complex aqueous solution. Water and ethyl alcohol generally make up 97 per cent of the wine (the ethyl alcohol content of a red table wine may vary from about 9 to 14 per cent). The remaining 3 per cent, which gives a red wine its distinctive color, taste, aroma, bouquet, feel, and charm, consists of fusel oils; malic, tartaric, lactic. and more than nineteen other organic acids; esters; tannins; anthocyanins and other pigments; cream of tartar; a very small quantity of grape sugars and the intermediate products of fermentation; minerals; half a dozen vitamins; and sundry other compounds including substances from the bodies of the yeast. These materials further commingle and marry in the bottle,



A modern winery uses both automation and hand processes: at top, a workman adjusts the flow of wine from 100,000-gallon fermenting tanks; above right, rotating air presses; right, an over-all view of a bottling room. In making sparkling wines, yeast and sugar are added to produce fermentation in the bottle. After fermentation, bottles are inverted and spent yeast accumulates in the neck, above left. The neck is frozen into an ice plug of sediments, which is then expelled by the pressure of carbon dioxide, left, and the bottle is recorked.

finally turning into a finished wine.

The need for prolonged aging is overemphasized nowadays, and many people hold the misconception that great age is a guarantee of a great wine. This is rarely the case. Every wine has a life span: its youth; its prime, when it is smooth, mellow, and balanced; and its senescence, when it deteriorates in quality to undrinkable worthlessness. All types considered, 75 per cent of the wine produced in the world today has reached its prime by the time it is one year old. Among red wines, most Beaujolais and the lesser red wines of France are best consumed before they are two years old; good Burgundies improve for ten years; and exceptional Cabernet Sauvignon wines will continue to improve in the bottle for ten to thirty years.

In tasting a newly opened bottle of wine there are sound reasons for conforming to the formal rituals of the oenophile. The first glass of wine is held before a bright light and scrutinized for clarity. If a good wine has been bottle aged for a protracted period of time, a sediment of oxidized tannins and coloring matter will have formed. This reddish-brown substance, called the dregs, has settled out of the wine. The sediment is not a defect in any sense, but an inevitable event that takes place during the life cycle of any fine red wine. Transportation of the bottle from the store, or even from the cellar to the table, will roil the sediment. Therefore, the bottle must be placed upright several days in advance of consumption and then be served with great care or the ebb and flow of repeated pouring will muddy the wine, which ideally should have great limpidity and brilliance.

The color of the wine tells much about its condition. If the wine is properly high in acids it will be bright red in color. As red wines lose their acidity they turn from red to brownish red, and in wines of great age, to tawny. A hazy cloudiness in the wine often indicates bacterial spoilage. If your wine shows this complication, return it to the wine steward; its appearance must not be disfigured by such an accumulation.

Next, the aroma of the wine is tested. The graceful high sides of the traditional tulip-shaped wine glass are functional in design as well as being esthetic, for they serve to imprison and concentrate the volatile odors of the wine at the top of the glass. Gently swirling the wine in the glass brings out the maximum bouquet. In testing these odors one must literally sniff the wine, for the receptors of smell are located high in the nasal cavity and only active sniffing can create the necessary updrafts to carry odors over these specialized receptor nerves. The discriminating nose can readily distinguish the fruity aroma of grapes and the masculine bouquet of the esters and alcohols. On the other hand, if souring has taken place, the odor of vinegar will become painfully obvious at this time. Red wines should be served at about 65°F. and should not be chilled, for this numbs them, increases the apparent astringency, and incarcerates the bouquet.

While the receptors for smell are exceedingly sensitive, they fatigue rapidly, although temporarily. A woman's perfume, for example, goes unnoticed by her companion after she has been in his presence for a few minutes; however, should she leave the room and then return, his receptors for smell again become briefly aware of this aspect of her charm. Since so much pleasure is obtained from the bouquet of excellent wines, they should be drunk a sip at a time, the intervals insuring the recovery of the delicate receptors of smell.

Finally the wine is tasted. It is now that the presence of the wine tannins becomes obvious, creating a pleasing pucker in the lining of the mouth. Many red wines are quite astringent when young, but the tannins are altered with age and the same wine softens and mellows.

There are approximately ten thousand gustatory receptors, or taste buds, imbedded in the tongue and soft palate of the mouth. They are essentially responsible for registering only five taste modalities: sweet, sour, salty, bitter, and metallic. The tastes experienced by man are believed to be a blending of these primary sensations, combined with the information simultaneously recorded by the receptors for smell.

Incongruously, the characteristic flavors of foods and wines are determined mostly by their odoriferous, rather than sapid, constituents. This is partly due to the fact that the re-

ceptors for smell are a thousandfold more sensitive than the taste receptors and respond to a larger variety of substances. Experiments show that it is the acidity of the foods and wines that stimulates the receptors for sour taste. Therefore, the fewer strong acids present in the wine, the less sour the taste. In addition, one sensation can be overpowered by another, and much of the potential sourness of the acid in a wine must be masked by other components so that the net impression of the acids will be an agreeable tartness. The receptors for bitter taste are concentrated at the back of the tongue, and not until the wine is swallowed does it contact this area, eliciting a delightful lingering bitterness called aftertaste, or finish.

The over-all flavor of the wine is therefore the mélange of impressions recorded by the senses. The evaluation is initiated with the visual acceptance of the wine and culminated when the brain sorts out, integrates, and hedonically scores the millions of nerve impulses caused by the aroma, bouquet, astringency, feel, and taste. This can be a very pleasurable process. The physiological basis of evaluating flavors, especially the modifying influences of one substance on the taste of another, reveals why particular wines accompany certain foods better than others. While some overzealous wine promoters advocate "drink whatever wine you want with any dish," this advice is not necessarily sound. The robust flavor of some wines will completely dominate delicate dishes and vice versa. For instance, it would be foolish to serve a full-bodied red Burgundy with a delicately flavored Dover sole, nor should a light, young Beaujolais be drunk with a hearty Italian dinner. These combinations are as uncomplementary as fudge sauce on grapefruit slices. Wine is the perfect companion of food, however, and the only rule is to make sure the two mutually enhance the flavor of each other. This criterion met, is it any wonder that wine is almost as old as the thirst of man? *Bon appétit.*

Terraced vineyards at Côtes-du-Rhône, France.

Ridiculed, Rejected, But Still Our Ancestor NEANDE

Neanderthal: The word is now so familiar, and its implications of the archaic so clear, that it describes things quite unrelated to its original meaning. Modern writers refer to ultraconservative and moss-backed attitudes in social affairs as "Neanderthal," and occasionally call the holders of such views "Neanderthals"; likewise, so-called Neanderthals in politics are regarded as human fossils, with the further implication that they properly should have become extinct long ago.

As we shall see, this implication of extinction has been developed to a surprising degree by the majority of scientists who have studied the genuine human fossils called Neanderthals. But is this majority right? Did extinction of the Neanderthals come, as we are usually led to believe, because they were too different to qualify as our ancestors? If a Neanderthal existed today, if he appeared in a crowd of the rest of us, what would people say?

Would the robust bony structure, massive chest, and developed musculature be especially noticeable under a modern suit of clothes? Of course, clothes would not hide the broad, thick hands or the massive face beneath the heavy bony brow—particularly if this Neanderthal should smile and display the big front teeth that, more than anything else, hold the key to the difference between a Neanderthal and an average modern man. In his time, in a world where tools were crude, many manipulatory tasks had to be handled by that original built-in, the human dentition. Natural selection favored heavy-duty teeth that could withstand wear and tear; to support such teeth required a face somewhat larger than modern size.

The term Neanderthal itself refers to a valley in the heart of western Germany, through which flows a stream, the Düssel, which joins the Rhine at Düsseldorf. In the seventeenth century, this quiet valley was a favored place for picnics, and was particularly admired by the Düsseldorf organist and composer Joachim Neumann, who signed some of his works "Neander," the Greek translation of his name. After his death, local people began calling the secluded valley, then spelled *thal* in German, Neanderthal.

By the mid-nineteenth century, industrialism was transforming the Neanderthal with quarrying operations in the limestone cliffs that loomed above the stream bed. In 1856, quarrymen discovered a human skeleton buried in a small cave, the Feldhofer Grotto, but they did not recognize the bones as human; in fact, they unceremoniously shoveled them out of the cave while preparing it for blasting. However, the quarry owner preserved the bones, and their importance was recognized later by Johann Karl Fuhlrott, a science teacher at the local high school, who was an enthusiastic student of the region's natural history. Unfortunately, the bones were discovered so casually and unprofessionally that only the larger pieces of what must have been a complete human skeleton were preserved. None of the smaller bones, the fragile parts, or the teeth were saved.

Fuhlrott not only realized that the bones were human but also that they were of most unusual and possibly "primitive" form. Unlike certain more recent discoverers of important hominid fossils, he also realized that to study and interpret them required training he did not possess. So he enlisted the aid of Herman Schaaffhausen, professor of anatomy at Bonn. Both men then presented their evidence for discussion at a number of scientific society meetings, suggesting that the bones might have belonged to an individual of some antiquity. Actually, the antiquity they had in mind went back only to the pre-Celtic and pre-Germanic inhabitants of northern Europe hinted at in the writings of classical authors —a far cry from the forty thousand years and beyond that we now know must have been the case.

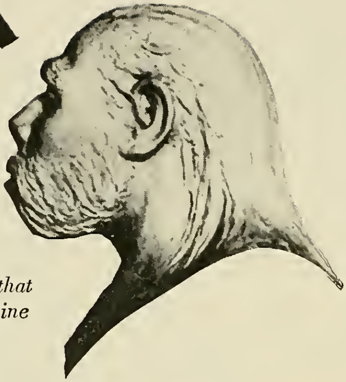
Unfortunately, respected and "competent" opinion on the significance of the Neanderthal skeleton was delivered before a basis existed for appreciating either the extent of human antiquity or the possibility of evolutionary changes and relationships in a biological sense. The relationship between ancient human remains and the course of man's development has always brought a heightened, emotion-laden concern, and even supposedly competent opinion has frequently been less than scientically objective. This is true even for recent exciting finds in Africa, but perhaps the most bizarre spectrum of opinion concerning a human fossil was that offered in supposed explanation of the original Neanderthal skeleton.

Suggestions that this ancient person had suffered from idiocy, lunacy, rickets, premature ossification of cranial sutures, and various other pathological manifestations came from a series of "experts." Others, reflecting the sense of superiority felt by denizens of such places as London, Paris, Berlin, reflected their prejudices when they compared the supposedly "inferior" traits of the Neanderthaler to features they assumed to be characteristic of people inhabiting various benighted places in the modern world—such as Holland or Ireland. One distinguished German anatomist dismissed the skeleton as that of an "old Dutch-

THAL

y C. LORING BRACE

e characteristic
front teeth
dolescent stage shown)
ved Neanderthal Man
manipulative tools.



From top, the models compare head of Neanderthal Man with that of a more ancient pithecanthropine and a chimpanzee.

man"; an eminent French scholar referred to it as a robust Celt resembling "a modern Irishman with low mental organization."

Possibly the most amusing interpretation was based on the following data about the Neanderthaler: (1) evidently the left elbow had been broken early in life and had healed in such a way that movement was subsequently restricted; (2) the individual was presumed to have suffered from rickets, so it was suggested that pain from the elbow and the rickets had caused the person to knit his brows in a perpetual frown. This became ossified, producing what has become an outstanding characteristic in descriptions of Neanderthal form—the heavy ridge along the brow. Adding to this pathological "evidence," Schaaffhausen's anatomical colleague from Bonn, Professor Mayer, suggested that the bowed femurs might testify to a lifetime spent on horseback. Assembling all this, Mayer suggested the Neanderthal was a deserter from the Russian forces that chased Napoleon back across the Rhine in 1814 and, more specifically, a rickety Mongolian Cossack who had crawled into the cave for refuge.

The most significant opinion came from Rudolf Virchow, a German who was a recognized leader in cellular pathology and also highly respected as an anthropologist and liberal politician. This critical and uncompromising champion of the strict scientific principles of deduction and inference said that there was virtually no way of determining the antiquity of the find because with it were no associated tools or animal bones. After a detailed, careful review of the notable features of the skeleton, he pronounced it pathological. Naturally, few even thought to question the judgment of one of the world's leading pathologists.

To counter those who claimed great antiquity for the skeleton, Virchow pointed out that it was that of an individual who was past fifty years of age. This argued that the Neanderthaler had belonged to a civilization that cared for, and assured the survival of, the middle-aged and elderly, which would have been most unlikely in the remote prehistoric period that some had suggested. With this logic Virchow increased the probability, so his readers believed, that unusual morphological features of the skeleton could be accounted for only by invoking some sort of pathological involvement. It was a cautious, critical, and skeptical approach; unfortunately, Virchow was using the right reasons to reach the wrong conclusion.

In 1858—two years after the Neanderthal discovery—a visit by British scholars to the site of Boucher de Perthes' archeological researches in northwest France led to the conviction that man must have been in existence for a substantial period of time prior to the dawn of written history. This conviction was confirmed by groups from both Britain and France in the succeeding year. And in November of the same year, 1859, appeared Darwin's book *Origin of Species*. It changed forever the entire frame of reference for appraising the significance of sequences of prehistoric animals—including the human animal. After a decade of debate, evolution by means of natural selection became a dominant aspect of natural science in both England and Germany.

In France, however, Darwin's reception was quite different. Twenty years after Darwin and A. R. Wallace (who had independently hit on the same ideas) published their preliminary essays, the term "evolution" was cautiously introduced to French biology. But in France, instead of meaning descent with modification by means of natural selection, the concept of evolution was so similar to the theory known as "catastrophism"—featuring extinctions, invasions, and successive creations, supported by Cuvier during the first third of the nineteenth century—that it largely amounted to a relabeling of the earlier view.

At any rate, Darwinian evolutionists were not yet able to do much about the initial Neanderthal interpretations. Still lacking was an adequate basis for appraising either the skeleton's antiquity or its evolutionary significance. And an aura of peculiarity has clung to the Neanderthals ever since. To this day, most professional anthropologists and paleontologists, with myself as one of the unpopular exceptions, repeatedly refer to the Neanderthals as "extreme," "specialized," or "aberrant," and deny that they were ancestors of modern man.

Another decade passed. Then, exactly thirty years after the first Neanderthal discovery, vindication of the Schaaffhausen–Fuhlrott views came from the discovery of two more fossil skeletons, this time in the commune of Spy, in Belgium. Both resembled the original Neanderthal so closely that to claim that their characteristics, too, were explainable by idiocy or pathology was straining coincidence too much for most people, although Virchow continued to cling to his pathlogical judgment.

The excavation techniques this time had been more careful; the jaws, teeth, and many of the smaller bones were preserved. Not only did the Spy skeletons reinforce the view that the Neanderthal form characterized an entire prehistoric population; the Neanderthal population to which they evidently belonged could now be dated, relatively speaking, for the first time. This was because archeological research during the thirty years had provided a broad framework for the arrangement of prehistoric materials: the most recent of the Stone Age categories was the Neolithic, a period of crude crop tending and polished stone tools; most ancient was the Lower Paleolothic, characterized by heavy hand axes of chipped stone (bifaces) and a hunting mode of existence.

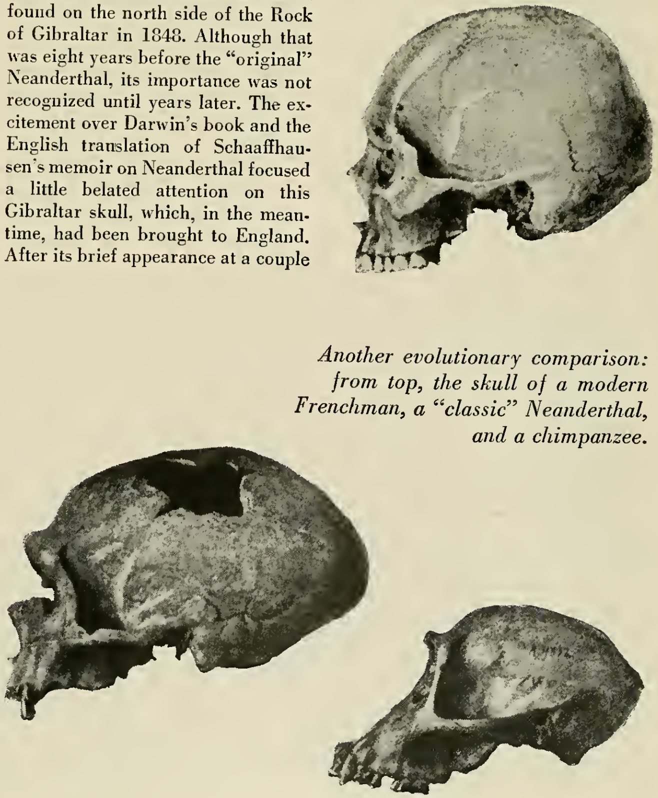
The Spy Neanderthals were fitted into a category one degree less ancient than the Lower Paleolithic, because they were found with tools of a type first recognized in excavations at the southern French village of Le Moustier. With today's radioisotope dating techniques we know that the cultural traditions of the Mousterian Neanderthals extended from about 35,000 B.C. back at least 50,000 years to somewhere between 80,000 and 100,000 years ago. In the 1880's, however, there was no way to make even rough estimates of antiquity other than to note that such-and-such cultural assemblage was older or younger than another one. Hence the Mousterian culture was considered a degree younger than the Lower Paleolithic hand axe cultures, but still much older than that of the earliest cultivators and herdsmen.

Since the Spy discovery, except for narrowing the dates and refining our knowledge of how the Neanderthals provided themselves with clothing and shelter, we retain pretty much the same picture of their life and times that was available by the end of the nineteenth century.

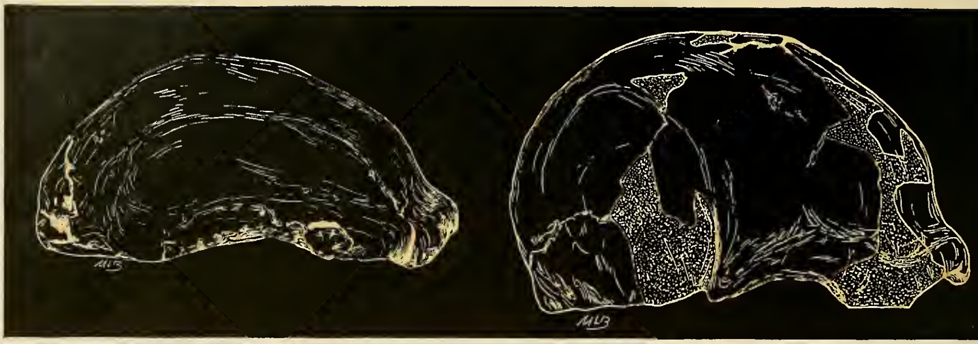
The Spy discovery, followed by others, provided a frame of reference for a few previously uncovered isolated fossils. One of these was a skull found on the north side of the Rock of Gibraltar in 1848. Although that was eight years before the "original" Neanderthal, its importance was not recognized until years later. The excitement over Darwin's book and the English translation of Schaaffhausen's memoir on Neanderthal focused a little belated attention on this Gibraltar skull, which, in the meantime, had been brought to England. After its brief appearance at a couple of scientific society meetings, it was consigned to the Museum of the Royal College of Surgeons in England, where it remained unappreciated until after the end of the nineteenth century. Not until a German anatomist made a detailed comparison with other Neanderthal skeletal material did the English become interested enough to initiate studies themselves.

The other fossils that could be placed in context because of the Spy discoveries were mandibles. The original Neanderthal lacked face, jaw, and teeth, and, although it was suspected that individual robust mandibles found in France, Belgium, and Czechoslovakia came from Neanderthal-like individuals, it remained only a suspicion until the Spy remains raised it to a substantial probability.

Meanwhile, the years between



Another evolutionary comparison: from top, the skull of a modern Frenchman, a "classic" Neanderthal, and a chimpanzee.



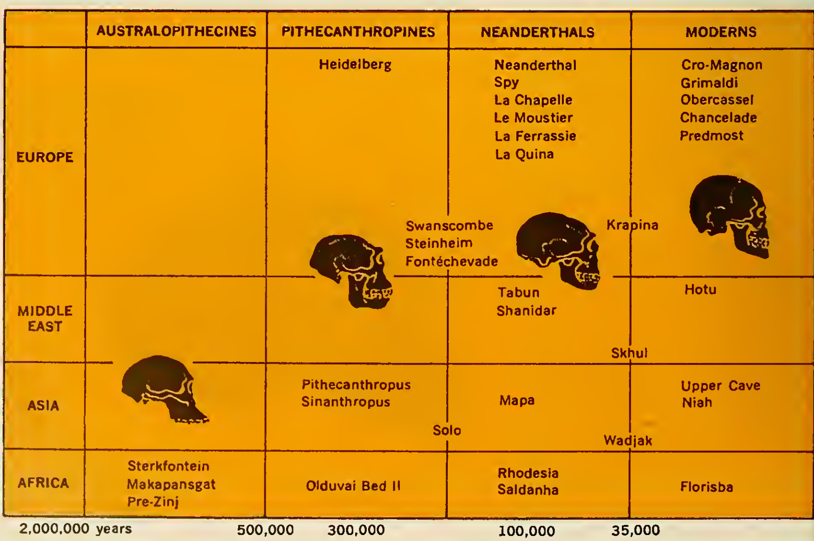
1856 and 1886 saw the recovery of artifacts and skeletal remains from the period immediately following that of the Mousterian and Neanderthal. The artifacts were more finely made than those of the Mousterian, many more kinds of tools were represented, and tools of worked bone were found for the first time. Some of them were decorated with graceful, realistic engravings showing many of the extinct animals whose bones occurred in the same deposits.

And for good measure, the human skeletal remains from those Upper Paleolithic levels, including the famous Cro-Magnon discovery, displayed aggregates of traits that allowed their describers to claim the creature had differed in no way from modern man. This depended on viewpoint. The skeletons indicated distinctly heavier musculature and larger faces, jaws, and teeth than the *average* modern man has. However, a small but sufficient number of living humans do attain this level of ruggedness. At any rate, the archeological record revealed the ancients were skillful hunters as well as talented artists. And, with their skeletal form suggesting they should be considered ancestors of contemporary Europeans, the modern interpreters studied and discussed the Upper Paleolithic men with an almost familial pride.

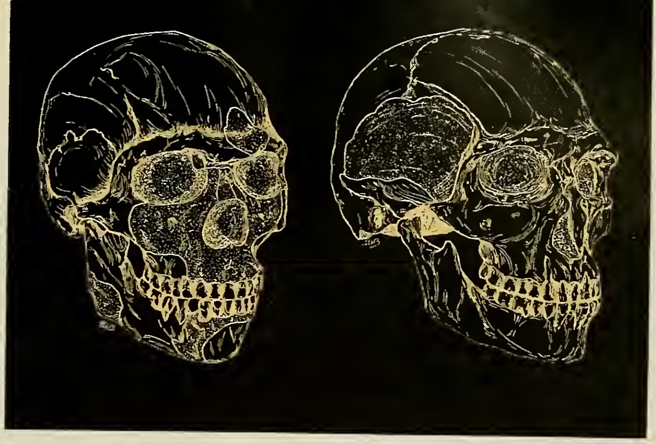
Next came an important discovery in the other direction of the time scale. The decade following 1886 brought the discovery and discussion of a very different and far older form —the famous *Pithecanthropus erectus* from Java. When the young Dutch physician, Eugene Dubois, found it in the Far East in 1891-92, opinions varied almost as much as those that greeted the first Neanderthal. By the turn of the century, however, a fair percentage of those qualified to judge had accepted the specimen as representing a true, if primitive, human being. Both *Pithecanthropus* and Neanderthal stood as erect as we do.

Then, at the very end of the nineteenth and for the first five years of the present century, came the discovery and description of the remains of between 14 and 15 Neanderthals from a Yugoslavian site at

The evidence for human evolution can be arranged in four stages: Australopithecine, Pithecanthropine, Neanderthal, Modern. Proportions are not to scale; Neanderthal and Modern represent only 5 per cent of the two-million-year period.



These skull casts show "recent" ›olutionary gradation. From left: he original Neanderthal; Spy II, with higher forehead; Skhul V, a Neanderthaloid; Predmost III, a full modern (see chart below).



Krapina in Croatia. But there was not a complete long bone or reconstructible skull; the Krapina population is now known chiefly for adding to our knowledge about the human dentition. A total of 263 individual teeth was found.

It is evident that by the beginning of the twentieth century the modest collection of evidence concerning the course of human evolution was ripe for a thorough appraisal. This was done—in simple, logical, Darwinian fashion—by the Strasbourg anatomist and anthropologist Gustav Schwalbe in his book *Studien zur Vorgeschichte des Menschen* ("Studies on the Prehistory of Man").

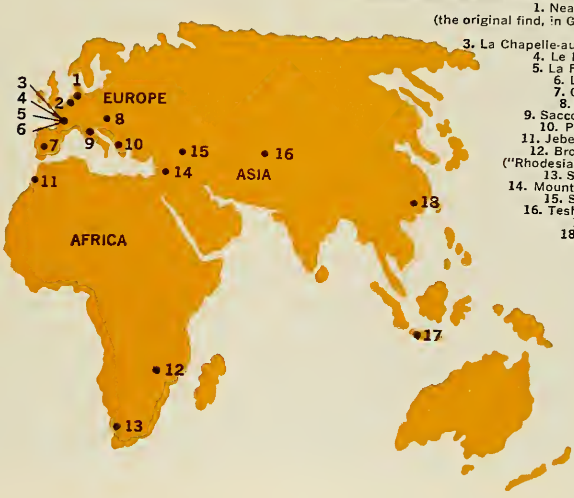
He regarded Dubois' *Pithecanthropus* as representing the earliest known human population ancestral to all later men. Today, most scholars accept this part of his conclusions, although few now separate *Pithecanthropus* in a formal taxonomic sense from genus *Homo*. Consequently, *Pithecanthropus* becomes *Homo erectus*, but non-technically we can go on referring to members of this species as pithecanthropines.

Descended from the pithecanthropines are the Neanderthals, whom Schwalbe placed directly in the line of human evolution, first as the separate species *Homo neanderthalensis* and later, for reasons not altogether clear, as *Homo primigenius*. Actually, the general scientific belief today is that the Neanderthals were so like modern men that, if some were alive today, they could interbreed with *Homo sapiens* to produce viable fertile offspring. In other words, most anthropologists now favor classifying the Neanderthals as *Homo sapiens*, the same as modern man; at most, they would only add the subspecific designation *neanderthalensis*. But this does not alter the basic situation. The same people retain the old belief that Neanderthal was too different to qualify as our ancestor.

Schwalbe had been more alert than that. Having classed Neanderthals as a separate species, he then claimed they became extinct, not because they left no descendants, but extinct in the sense that the world today no longer has a distinct population of Neanderthals. For his time, Schwalbe's was the most balanced and logical approach.

Contrast it with the general idea held by zoologists and anthropologists in 1968. Almost no vestige of Schwalbe's appraisal has survived. Instead one reads varying versions of a view that contrasts the Neanderthals with us. They are written off as victims of "specializations"—although just why it is disadvantageous to be extraordinarily robust and to possess heavy brow ridges, faces, and teeth is rarely spelled out. Ultimately these inhabitants of western Europe are said to have succumbed to the invasion of populations of fully modern form who had evolved somewhat mysteriously "in the east."

Why such a change in viewpoint? For an indicator, we turn to reminiscences by the late Sir Arthur Keith, the dominant physical anthropologist in the English-speaking world throughout the first half of the twentieth century: "I had supposed that man's ascent had been made by a series of succeeding stages [but] . . . discoveries were being made in



Sites of skeletal discoveries show that Neanderthals inhabited three continents:
1. Neanderthal (the original find, in Germany)
2. Spy
3. La Chapelle-aux-Saints
4. Le Moustier
5. La Ferrassie
6. La Quina
7. Gibraltar
8. Krapina
9. Saccopastore
10. Petralona
11. Jebel Irhoud
12. Broken Hill ("Rhodesian Man")
13. Saldanha
14. Mount Carmel
15. Shanidar
16. Teshik Tash
17. Solo
18. Ma-Pa

France which indicated to my mind that Neanderthal man could no longer be regarded as an ancestor. The stratum containing his fossil bones was followed at once by one containing the fossil bones of our type—the modern type. Apparently we moderns had invaded Europe and exterminated Neanderthal man."

He was referring to the Neanderthal skeletons found in 1908, one being the famous "old man" of La Chapelle-aux-Saints from Corrèze—the most complete, best-preserved Neanderthaler discovered up to then and for a long time thereafter. This find led to an overwhelming monograph published by paleontologist Marcellin Boule of the National Museum of Natural History in Paris. In sharp contrast to Schwalbe, he concluded that Neanderthal form was too divergent to represent a stage in the evolution of modern man. Every one of Boule's crucial points eventually turned out to be questionable, but in the meantime even Schwalbe inexplicably conceded that the Neanderthals had become extinct without issue. When Schwalbe died two years later, in 1916, his evolutionary views, with a few exceptions, died with him.

Then, fifteen years later, came the discovery of bones at the cave of Mugharet-es Skhul—on the slopes of Mount Carmel in what is now Israel. These bones showed a mixture of Neanderthal and modern traits in proportions so equal that the term Neanderthaloid was coined to acknowledge that here was no full-scale Neanderthal. It had been Boule's verdict that there could be no intermediaries, yet here was an intermediary.

Various hypotheses were offered in explanation. One of them was based on the idea that the Mount Carmel deposits were earlier in date than western Europe's "classic" Neanderthals, so perhaps here in the Middle East were the remains of the population that evolved into modern form—while the classic, or conservative, Neanderthals of the west remained isolated and unchanged.

Since such hypotheses were suggested, circumstances have changed. First, modern dating techniques place the Skhul remains at less than 40,000 years—in other words, right between the classic Neanderthals and the earliest moderns, in time as well as in form. Second, several good classic Neanderthals in the full flower of brows, jaws, and teeth have been found at Shanidar cave in Iraq, the heart of the area "to the east." Also indicating that classic Neanderthals were not isolated in western Europe is the discovery of Neanderthals in Morocco, Greece, Israel, Uzbekistan, and even China—plus candidates for Neanderthal status that have existed for years in Java and Africa as well.

Certainly there is no longer any reason to regard the Neanderthals as an isolated European phenomenon. Nor is there any reason to reject their candidacy for status as the direct ancestors of more recent men. So, in an interpretive sense, we are right back where Gustav Schwalbe left us in 1906. Because the evidence with which Boule contradicted Schwalbe's relatively simple approach was faulty at that time, and has not been supported since then, it is reasonable to ask what impelled him to view the world as he did.

To begin with, we should realize that Marcellin Boule was trained in late nineteenth-century France, where the concept of "evolution" was far more akin to the catastrophism of Cuvier than to the Darwinian views in which Schwalbe and Keith were trained. Boule explained change in the human fossil record by extinctions and invasions with little concern for adaptive response and the mechanics of biological change. His view could be called "hominid catastrophism."

That it should have come to dominate thinking about the course of human evolution in general, and the Neanderthal's role in particular, is due in large part to the accidents of history. Prior to 1914, the most effective attempt to deal with human origins from an evolutionary point of view had been produced in a German academic context and had considerable influence elsewhere. But the invasion of Belgium and the burning of Louvain in 1914—in short, the initiation of World War I—seriously tarnished the civilized and scholarly image that German academia had previously enjoyed. From the point of view of the study of human evolution, it was particularly unfortunate that the tradition associated with Schwalbe should have been located at Strasbourg. Political control of Alsace-Lorraine, which had been in German hands since the Franco-Prussian war of 1870-71, returned to the French after World War I. They promptly fired the German faculty of the university at Strasbourg ending the tradition that had flourished there under Schwalbe.

Also after the war, major works summarizing our knowledge of human origins were published by Boule and Keith, among others; and two subsequent generations of professional students of human evolution have grown up schooled to believe that the prehistoric Neanderthals were a peculiar group, not because of anything pathological as Virchow once thought, but rather because of their assumed failure to adapt.

Our knowledge of the events that occurred in the remote past will always be incomplete, and proof for one or another interpretive hypotheses can never be final. Where the subject of our concern is as rare and fragmentary as Neanderthal skeletal remains, we have seen how the political and intellectual history of the past hundred years has, in some instances, played a more significant role in determining which points of view find favor than do the objective pieces of evidence themselves. From what we actually know, it is probable that if a properly clothed and shaved Neanderthal were to appear in a crowd of modern urban shoppers or commuters, he would strike the viewer as somewhat unusual in appearance—short, stocky, large of face—but nothing more than that. Certainly few would suspect he was their "caveman" ancestor.

A Neanderthal's physiognomy? The restorations at top left and bottom are generally acceptable versions of the "old man" from La Chapelle-aux-Saints; the third, based on a skull from Le Moustier, has been called a caricature of man's ancestor.

From 1960 through 1967 we have closely followed the social relationships formed by individual members of a captive pack of timber wolves *(Canis lupus)* at the Brookfield Zoo in Chicago. The pack was started in 1958 with five yearling cubs—three females and two males, all related as siblings or half-siblings—and has been kept together in the same elliptical enclosure for the past ten years. The relationships that developed between the wolves have remained relatively constant, and so have an analyzable origin.

In spite of the natural changes created by the maturation of subsequent young and their emergence into the adult group, the social organization is maintained by the behavior of the individuals within the group—that is, one member permits the typical social behavior of another, but restricts its antisocial behavior. Such social actions can be conveniently referred to in rather anthropomorphic terms: a submissive wolf "defers to" a dominant wolf, the rank of the most dominant wolf is "enforced" by some of the lower-ranking animals, one wolf "punishes" another, and so on.

Among adults one animal may be extremely to slightly dominant with respect to another, while the other is slightly to extremely submissive. Among the juveniles of the pack, relationships are often variable and changeable, and they are marked by frequent play in which adult dominant and submissive roles are mimicked and interchanged. The young often assume a playful and solicitous role toward adults, while the latter are by and large indulgent toward the young. Although separate hierarchies exist within each sex, the dominance relationships sometimes extend to the opposite sex. The highest-ranking, or alpha, female, for example, tends to exert her dominance over many of the lower-ranking males. Size does not appear to be an essential criterion of dominance either within or between sexes. Rather, some as yet poorly understood personality factor seems to have the greatest sway.

Behavioral interactions vary with the environmental situations of the captive pack, as well as with the motivational states of the particular animals involved. The dominance relationships are more fully expressed in stressful situations arising from conflict over food, mates, objects of interest, or desirable space. Dominance is far less apparent when such stress is not present.

In the typical dominant–submissive interaction, the ranking wolf carries his head erect and his ears forward, his body in a normal position, and his tail straight out and behind him; the deferring submissive animal approaches the dominant with his head down low and his ears back (but not flat against the head), his body wriggling in a crouching walk, and his tail pointed downward and fluttering. The submissive animal will often attempt to get his head beneath the head of the dominant animal and to lick its mouth or muzzle. The dominant animal may respond by mouthing the muzzle of the submissive animal, while at the same time raising and wagging his tail. Or it may ignore the submissive animal's gestures and either stand still or trot away. These responses vary in frequency and in degree between different animals of the pack, and they are, in general, seen in proportion to the relative social rank of the individuals involved. They do not, however, occur every time two animals come together.

Interactions between wolves in situations of stress often result in the submissive animal's being physically attacked by the more dominant. In such cases, the dominant may first threaten the submissive animal in order to achieve the disputed objective. This is done by the dominant animal's growling and baring his teeth. If the submissive animal is not diverted, the dominant will attack and bite the subordinate, knock him down, stand over him and bite him, and then finally just hold him on the ground. The subordinate wolf either pulls his legs up against his body or pushes gingerly at the body of his attacker. His tail is characteristically tucked between his legs. He may either cover his neck by holding his head down or attempt to hold the attacker's mouth away by nipping the attacker's chin. When the subordinate finally gets up, he usually walks off with his tail tucked between his legs. Often, however, he goes right back to the object of dispute and is punished again.

The Social Organization of Wolves

by Jerome H. Woolpy

The separate roles within the pack consist of the dominant, or alpha, male, the alpha female, the subordinate males and females, the peripheral males and females, and the juveniles. At some time or other, the alpha male is deferred to by all the other members of the pack. He is the focal point of the "solicitous affection" of the pack; that is, the other members often run up to the alpha male, wag their tails, and paw and lick at him. Frequently, they all gather around him and do this at the same time. This is generally accompanied by howling and is called a "greeting ceremony." He is also the

One of Brookfield Zoo's mating pairs. Male is at top.

A phalanx of wolves, above, strides around the zoo's enclosure. At top left, the dominant, or alpha, male, in the center, receives the "solicitous affection" of the pack during the "greeting ceremony." The alpha female, at far left, in a gesture with her forepaw is actively courting the alpha male. The pits in the ground (also visible in the photograph of the alpha female running at full tilt) are the two entrances of the den, which the wolves themselves excavated, having spurned a man-made house built by the zoo. The white wolf in center photograph is the lowest-ranking female, shown acknowledging the rank of the alpha female by muzzle licking. Below, typically excluded, she slinks off.

›rincipal guard of the territory and ›atrols around the periphery of the ›ack, perhaps looking for intruders. The alpha female is dominant over ıll the other females and most of the nales. She controls the relationships ›f the rest of the females to the pack. The subordinate males and females, ogether with the alpha male and fe-nale, form the effective nucleus of he pack. The peripheral males and emales are kept out of the nucleus ıs a result of their manifest submis-iveness and low rank in the social ıierarchy. They are forced to remain ıt some distance from the nucleus nost of the time, although they at-empt to participate in pack activities ıs much as possible. The juveniles pend most of their first year in or ıround the den and, during their econd year, gradually become part ›f the pack nucleus.

Most of the actual fighting is of ess than a full-blown nature and ends [uickly with the submission of the oser. Occasionally, however, espe-ially around the breeding season, ll-out battles occur in which the oser may be severely injured. In nost battles that last more than a few noments there is considerable gang-ng up, with several animals attack-ng one; occasionally one animal will ttack another, and a third animal ill help subdue the attacker.

The highly structured social or-anization observed at Brookfield riginally arose among an untutored roup of cubs removed from the in-uence of adults. Therefore the social ehavior appears to have a clearly eritable basis. However, the special oles (alpha, beta, etc.) are not rictly heritable among the individ-als of the group. Exchanges of roles ave been effected, and the wolves in-olved appear to have the capacity to ssume either dominant or submis-ve ranks with all of the appropriate ehavior. Thus the behavioral capac-ies are genetically determined as ›ecies characteristics. Furthermore, nce the social organization limits ıd structures the mating, the be-ıvior must be a species characteris-c. If this were not the case, social behavior would probably be under-going constant extremes of chaotic variation. For example, some roles would be reproduced in excess, while others would not be reproduced at all.

he alpha male in a yawn. The 'olves, curiously, avoid eye ›ntact with humans and cameras.

The social order is rather stable, despite the maturation of young and their emergence into the adult hier-archy. Since many of the adults co-operate in raising the young, the possibility suggests itself that the young may develop allegiances based on the particular hierarchy in force during their juvenile period.

The yearling wolves at Brookfield did not develop consistent social re-lationships with the adult members of the pack. During the mating sea-son just prior to their second birth-day, however, all five of the cubs raised by the "original" Brookfield pack assumed a consistent rank in the social hierarchy. More importantly, all five of the cubs were consistently submissive to the male and female that held the alpha positions at the time of, or just before, this critical mating period.

As more offspring are raised in the pack during the reign of any given alpha animal, allegiances to him in-crease and reinforce his rank. Should the leadership change (as a result of death or challenge by an animal that was older than two years when the alpha position was assumed), the new alpha wolf is faced with intensi-fied social selection because he is without the firmly established alle-giances of younger animals. Changes in leadership may occur for several successive years and then remain stable for a considerable period.

Courtship and Mating

Courtship and the formation of mating pairs are controlled to a large extent by the social system of the pack. The organization determines which animals are allowed to mate, and the relationships between the hierarchies determine the pairs.

At Brookfield, intensified social activity, a concomitant to the repro-ductive period, lasts from December through March. Actual mating gen-erally takes place in February, and the litters are born nine weeks later. Two-year-old animals are capable of mating, although, when present, it is the older animals that do most of the mating.

Before the females become fully receptive, the younger, less experi-enced males begin to pursue them, to sniff and lick their hindquarters, and to attempt to mount them. At this stage the females either ignore the young males or, if they are too per-sistent, turn on them and threaten to bite them. The females' recalcitrance seldom deters males.

When the females become fully re-ceptive, the older males join in the pursuit. The older males differ in their approach to the females in that they begin, not simply by mounting, as the young males do, but often by dancing around the females, placing their forelegs along the ground, while keeping their hind legs erect, and wagging their tails (in the familiar posture of a playful dog). Part of the male's courtship dance includes nip-ping at the female's face, ears, and back, and mounting her side. After this display, the male attempts to mount the female. When a male mounts a female and clasps his fore-legs around her middle, the female may or may not avert her tail and stand firmly to allow intromission. If she does, a copulatory tie occurs (prerequisite of fertile mating), which ordinarily lasts about twenty minutes. At this time the female can drag the helpless male anywhere she chooses. A tie may occur without courtship, especially between two an-imals who prefer each other.

Females also court males; a female does this by greeting a male in the submissive way and then backing up toward his head with her tail averted. The male may respond to the court-ship by mounting. Toward the end of the mating season, the less-experi-enced males begin using the court-ship methods; however, courtship rarely improves their chances of suc-cess with the females.

Almost all of the adult animals show indications of a desire to mate. The social behavior of the group places great restrictions on mating activity, however, and complete cop-ulation is a rather rare occurrence. During the mating season group rivalry is greatly increased, and rela-tionships sometimes change perma-nently. Younger animals assert themselves and may displace older

ones or make way for other animals to raise their rank.

Intrasexual mating restrictions among the males prevent a good deal of mating. The more dominant males constantly watch the less dominant males and frequently chase them away from receptive females. These acts of contraception usually occur during direct competition over a specific female. For example, when two males are both attempting to mount a female, the more dominant will try to force the less dominant animal away; but when a peripheral male is involved with a receptive female, direct competition need not necessarily occur for the nuclear males to break up the pair. Generally they do so with a group charge at the prospective mates, which sends the peripheral male away on the run with his tail between his legs. After repeated attacks for attempted mating, the peripheral animals become so conditioned that a "piercing glance" from one of their antagonists is usually enough to separate them from a prospective mate.

Among the females, intrasexual control is even more pronounced. A dominant female will violently attack any less dominant female that allows or entices a male to mount her. The frequent attacks of the alpha female upon the other females make it difficult for them to stand for a male. They become so nervous that they quiver underneath the male; thus intromission is almost impossible.

Intersexual control, although less common, is also a factor in contraception. Sometimes dominant animals may attack low-ranking animals of the opposite sex who are attempting to mate.

Another social factor that limits the breeding is mate preference. Males prefer to mount specific females and hence do not pursue all of the females, and females will not stand or avert their tails for most of the males. These preferences and aversions are by no means mutual. As a result, there is a lot of mounting without intromission and a lot of presenting with no mounting.

To add to these already restrictive conditions, the alpha male, who is often (although not always) preferred by most of the females, is the least inclined to mate of all the males; he may, indeed, prefer a peripheral female who is rarely allowed to mate.

Despite all these complications, five to ten ties occur each breeding season at Brookfield, mostly between the same two animals; and when they do, the whole pack gets very excited and gathers around the tied pair, often punishing one or even both of them. It is of further interest that when the alpha female is locked in a tie, the rest of the females have a few extra moments during which they may freely court preferred males. On one occasion, when the ever vigilant alpha female was tied, she dragged the male she was tied to over to another courting pair and vigorously attacked them.

The existence of a firmly established social hierarchy in both sexes places severe restrictions on the mating habits of the group. In the five consecutive seasons from 1960 through 1964, only one litter was born in the pack each year, and that litter was whelped by the same female every year and presumably fathered by the same male. (Paternity is assigned on the basis of a male's participation in a preponderance of copulatory ties with the female that whelps the litter. This has to be tentatively done in non-exclusive cases and is further complicated because the period between copulation and birth may vary: 62 ± 3 or 4 days.)

More irregular patterns of mating

At upper left, the alpha male marks a bush. This method of marking, or urinating, while typical of most dogs, generally occurs among the wolves in the Brookfield pack only in dominant males. Subordinate males and females do not raise their legs. Copulation is shown in the upper center photograph. Once intromission has been achieved the mating pair are "tied" quite literally, as at upper right. The tie will ordinarily last for about twenty minutes. Directly above, a low-ranking animal is "punished," while, at left, the alpha female emphatically rejects the courtship of a subordinate male.

were exhibited before 1960 and after 1964. In 1959 two litters were born. At this time the pack members were only two years old and may not have had fully developed social hierarchies.

Although two-year-old females show vaginal bleeding and attempt to court males, and two-year-old males attempt to mount females that are in heat, these attempts are largely unsuccessful. In the presence of older pairs, copulatory ties involving two two-year-old males (but no instances involving two-year-old females) have been observed. That little reciprocal courtship by either sex has been observed before three years of age suggests that this is the age at which wolves become socially integrated and serve as effective members of the mating population.

In spite of the severe social restrictions on actual mating, there is still a great deal of sexual activity exhibited by all of the adult members of the pack during the annual three-month reproductive period. Furthermore, even though effective mating is generally limited to the higher-ranking members of the group, the male of the reproductively effective pair is not usually the alpha male. In the Brookfield pack it has been the animal that was later to become the alpha male or the one that had previously been the alpha male. In fact, the mating activity of the alpha male appears to be reduced by the very nature of his role.

The hypothesis that social restrictions on mating also exist in the wild is supported by the fact that in an eight-year period of observation by David Mech and Paul Jordan of the protected Isle Royale wolf packs, pack size remained fairly constant and few cubs were seen. They also report, as does Adolph Murie on the wolves of Mount McKinley, that mating in the wild does take place when the pack is together as a group and that pair formation (or mutual preferences) is commonly observed. By contrast, according to R. A. Rausch, in parts of southern Alaska where wolf social organization is constantly being destroyed as a result of numerous wolves being shot by bounty hunters, birth rates are quite high, averaging close to one litter per season per female.

Thus it seems clear that mating preferences develop by the second mating season and are directed by the dominant male and female of that time. When these preferred animals are not in the enclosure, a temporary switch is sometimes made to another fairly dominant animal or at least to one that was an adult when the wolf in question was two years old. Although we cannot conclude from this evidence that wolves mate for life, we have never observed an older wolf develop a first preference for a younger one, nor have we ever observed reciprocal preferences between wolves of different ages. Furthermore, since these preferences develop by the second mating season, even an alien or migrant wolf would have great difficulty mating within an established group of wolves. Moreover, the observations of Mech and Murie suggest that some wolves are forcefully excluded from joining established packs.

The social organization of a single wolf pack (which is itself a subpopulation of the larger population in a given area) has the effect of selecting a non-random sample of the available genotypes from that pack to produce the subsequent generation. The over-all effective breeding population size would be much closer to the minimum number (two) than to the maximum number. Thus, from a purely statistical point of view, inbreeding would increase and genetic variability would decrease within the pack. During periods when the leadership is firmly established, the effective breeding population is small relative to the total number of adults, genetic variability is reduced because of inbreeding, and the genes of the few animals that do mate are disproportionately represented in the progeny. Leadership has been observed to last over several years and thus profoundly affects the mating structure of a pack. In this case mating is often limited to a single pair for several years. During periods when the leadership is not well established or has not been established for a long enough time, multiple matings occur between various animals involving many of the males with many of the females, the effective breeding population increases, genetic variability increases, and new gene combinations are created.

The social system, in sum, provides wolves with a means of controlling their mating and their population. I also produces a genetic mechanism that reduces the variability within the pack but, at the same time, increases the variability between packs; thu through group selection, this mechanism has the potential to accelerat wolf evolution.

Like the earliest men, and occupying a very similar ecological niche wolves are co-operative hunters wh live in small social groups containin at least one adult of each sex. A though the similarities betwee wolves and humans are, for the mos part, only analogous, resulting fror similar selection pressures, they ma also indicate some degree of homo ogy, which can help us to understan the roots of mammalian sociality For wolves, as for humans, social re lationships are formed early in lif and are nurtured by constant exper ence throughout the early years. Th

The howling ceremony, in this case prompted by a fire siren.

‹perience is essential for the devel-pment of appropriate social re-›onses and proper integration into ıe adult social structure (pack or ›ciety). Note, however, that wolf ›cial structure develops along pre-ctable lines whether or not socially ‹perienced adults are present. Hu-an social structure is considerably ore flexible and variable, although too is a complex function of genetic edispositions to assimilate and re-ond to certain types of experience.

The villainous characterizations e wolf has received in numerous lk tales and in our recent pioneer story have ignored that part of his ture that is friendly and gregari-s, with many of the qualities that admire in dogs. Evidence from atomical, fossil, genetic, and be-vioral studies indicates that the lf is most likely the ancestor of domestic dog. Although dogs fer from wolves in having smaller th and jaws, and slightly thinner nes, many features overlap. Be-viorally, wolves exhibit all of the tterns common to, but variable in, n's best friend. That is to say, the g is a fractionated and variously aggerated version of the wolf, created in the past 10,000 years by artificial selection. Both have similar vocalizations. Both hunt in packs, herd and scent, have similar expressive postures, and above all, both are gregarious, with a remarkable capacity for forming and maintaining social bonds with the animals around them. For the past eight years at the University of Chicago Behavior Genetics laboratories, Dr. Benson Ginsburg and I have studied the socialization of wolves. We found that wolves can be made to acquire very friendly, doglike behavior toward other wolves as well as toward humans. This can be conditioned even in adulthood, although it is more readily acquired in young cubs. Such "socialized" wolves wag their tails when humans approach and attempt to lick them and paw at them (as is shown in this issue's "The Authors" column). They may even greet them by putting their jaws around the chin of a human friend in a manner resembling the wolf greeting ceremony. Such social bonds, formed through continued experience, are quite lasting; and the friendly behavior will be retained even after a year of non-contact with humans, provided that the socialization is acquired or maintained when the wolf is older than one year. Wolves have even been raised as house pets, although they are not easily trained or disciplined and hence become extremely difficult to handle. They do, however, remain unaggressive and friendly to humans throughout. Even certain ethologists have ignored the wolf's co-operative and social nature and have misrepresented him as basically aggressive, "one-mannish," and monogamous. Although the wolf may have been our competitor for a similar ecological niche, he is not known to attack and prey upon humans; in fact the reverse has most often been the case. In situations where the wolf has been allowed to regulate his own population and prey upon wild game, his presence in the ecosystem has been of definite positive value in maintaining a natural equilibrium. This is a value that we are just beginning to appreciate. Hopefully, continuing investigations of wolf behavior and ecology will help change the wolf's public image and will reveal him as a creature to preserve and study and marvel at, rather than one to hate and destroy.

SKY REPORTER

It is nearly 100 years since extraterrestrial fragments were first identified in deep-sea sediments. Since then scientists have become certain that interplanetary space is strewn with debris—ranging from dust to chunks many miles across—but they are still a long way from being sure of its origin or even its quantity.

By means of airplanes, balloons, and rockets, the search for such material has been extended, from the ocean floor and the ancient ice and snow at both poles, to the atmosphere; and using satellites, into space itself.

But, as two researchers point out in the journal *Science*, "The total amounts of material are small, the individual grains are tiny, methods for distinguishing the real thing from contaminants are uncertain, the velocities at satellite heights lead to vaporization on impact, and the extent of survival and preservation on earth is unknown."

David W. Parkin of Bath University of Technology in England and David Tilles of Oregon State University report that current estimates of how much of this debris is accumulated by the earth in a day range from 1 ton to 30,000 tons. They find, however, that measurements "appear to be converging on 100 to 1,000 tons a day."

Parkin and Tilles argue that the most important step to be taken is to find ways to positively identify space debris that has landed on earth. This will lead to firmer conclusions about its origin and extent in space.

NEUTRON STAR

Radio astronomers at the Cavendish Laboratory at Cambridge University in England may have detected that most exotic of all objects in theoretical astronomy, a neutron star. They may, indeed, have found four of them. If these objects are neutron stars, they could rank with quasars and X-ray stars in what they reveal about stellar processes and matter itself.

The theory of stellar evolution holds that as stars become old and radiate less, gravity causes them to contract into small objects of very high density. Some 250 white dwarfs, in which the process has taken place, are now known. However, the theory also says that this gravitational collapse can continue to the point where matter itself is crushed into wholly new forms unknown on earth. The resulting object, a neutron star, might have the mass of the sun and yet be only five miles across. Writing in the British journal *Nature*, the group reported that the radio source in question is located in the constellation Vulpecula, and further measurements at Jodrell Bank have fixed the source at about 200 light-years distant from the earth.

SURVEYOR 5

Last September Surveyor 5 settled down on the moon's Sea of Tranquillity and made the first chemical analysis of lunar material.

Now at least one worker in the field disagrees with the announced conclusion that the lunar material is similar to basalts found on earth. He finds instead a similarity with eucrites—a type of meteorite thought to originate on the moon—whose proportions of heavy elements differ markedly from terrestrial basalt.

The Surveyor 5 results remain ambiguous because the techniques used cannot distinguish clearly between heavy elements when several are present. Paul W. Gast of Columbia University's Lamont Geological Laboratory registered his dissent at a New York symposium and in *Science*.

Gast warned that the assumption of lunar basalts would lead in turn to the assumption that the same geochemical processes that formed basalt on the earth have been at work on the moon. He expressed the fear that these conclusions would quickly diminish scientific interest in the moon.

Robert Jastrow, director of the NASA Institute for Space Studies and chairman of the New York symposium, was even more explicit: the conclusions, he said, would make manned exploration of the moon appear to be wholly unnecessary from a scientific point of view.

THE GALACTIC CENTER

From the earth we cannot see the center of our own Galaxy because of interstellar dust clouds. Radio astronomers have begun to map it, however, using the longer radio wavelengths that can pierce this dust.

Now a second window has been opened to the galactic center at the Mount Wilson and Palomar Observatories in California where an electronic device is used to record radiation at infrared wavelengths, shorter than radio waves but still longer than those visible to the eye.

According to a report in the *Astrophysical Journal*, excellent agreement was found between the infrared and radio observations. Both place the center of the Galaxy in the southern constellation Sagittarius. This dominant source of radiation is 5 to 10 minutes of arc across and is elongated along the plane of the Galaxy. The infrared results provide a picture of our Galaxy similar to the Andromeda Nebula (actually a galaxy), the great whirlpool of stars visible to the naked eye on clear nights as an extended hazy patch in the sky.

While the infrared observations provide welcome confirmation, radio astronomers are refining their techniques to overcome the fuzzy "images" they receive because of the long wavelengths involved. These astronomers are using the advancing limb of the moon as a knife-edge to give them sharp definition. Knowing exactly where the edge of the moon is located at any given time, they then note the exact instant a radio signal is cut off by the moon. Dr. F. J. Kerr at the University of Maryland is co-ordinating the galactic center studies.

JOHN P. WILEY, JR.

ELESTIAL EVENTS

There will be a crescent moon in the western sky each
ening in early May. First-quarter moon is on the 5th, full
oon on the 12th. Thereafter, the moon is in the morning
y. Last-quarter is on May 19 and new moon on May 27.
e early crescent moon may be seen again in the western
y from the 29th to 31st.

Jupiter remains the most prominent planet in the sky.
becomes visible at dusk high in the south, to the right
the star Regulus, in Leo, gradually moving closer to Leo
ring the month. Easily distinguished by its brightness
agnitude —1.7), the planet sets a little to the north of
st about midnight. Mars and Venus are too close to
sun to be seen. Saturn will become visible as a morn-
star in the east, rising about dawn, late in the month.

May 4: The Eta Aquarid reaches maximum, with no moon
interfere with early morning observations.

May 5-6: The moon, just past first-quarter, is moving
st Jupiter. On the evening of the 5th, Jupiter is visible to the east (left) of the moon; on the 6th, to the west (right) of the moon.

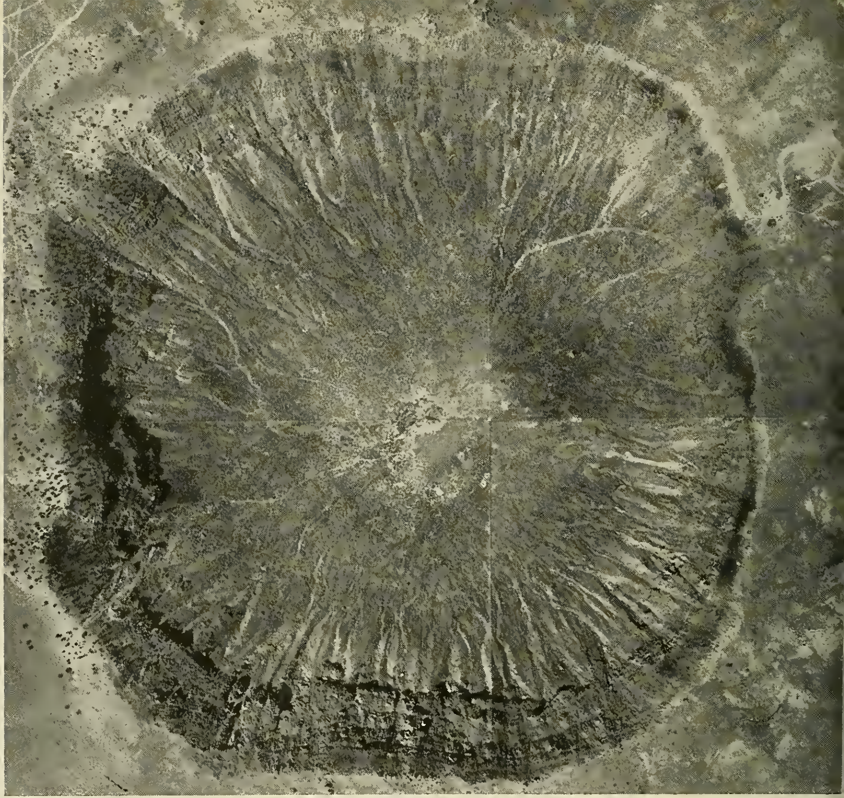
May 12: The moon reaches perigee (the point in its orbit where it is nearest earth) only four hours after the full moon. Look for very high perigee spring tides.

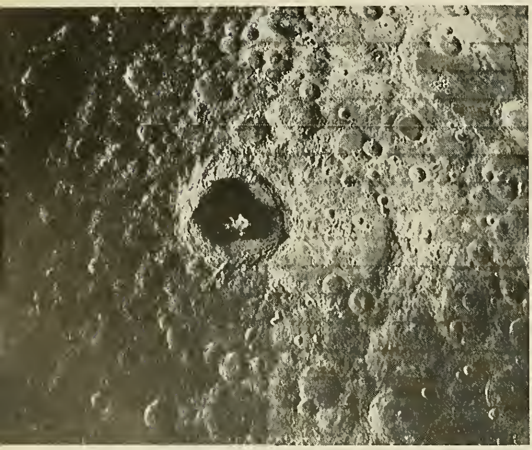
May 23: Mercury, an evening star visible from the 15th on, is at greatest easterly (evening) elongation. This is a favorable elongation; the planet is nearly 20 degrees above the horizon at sunset.

May 29-30: Mercury is above and to the left of the moon on the 29th; to the right and below it on the 30th.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:20 P.M. on May 1; 8:20 P.M. on the 15th; and 7:25 P.M. on the 31st; but it may be used for about an hour before and after those times.





Craters-A Ta

We continue to learn more about the strange pits seen on earth and on other planets. At top, Arizona's ancient Meteor Crater. Above, Orbiter III's photo of the moon's hidden side shows craters resembling those in close-up of Mars, right.

f Three Planets

by William K. Hartmann

Textbooks say there are nine planets in our solar system. We live on one and have sent space probes to two others, which makes it seem as if our explorations are coming along quite well. But the planets are accompanied by thirty-odd satellites. These include many large bodies that can be considered planets in a generic sense. Furthermore, orbiting the sun are more than 1,700 named asteroids spaced between Mars and Jupiter (some are larger than the smaller satellites). All told, there are probably forty bodies in the solar system that are eligible to be called "planets." Among these, astronomers frequently include our moon.

So far, we have had a good look at the surfaces of only three—our earth, its moon, and Mars. Strange circular depressions dominate the landscapes of the latter two and are scattered over the surface of the earth. Since all three have them, we may well ask, What are these depressions and how much have we learned about them?

The story begins with Galileo. When he turned his new "optick tube" toward the moon in 1609 and observed what we now loosely call "craters," he started a small but controversy-filled chapter in the history of natural science. The name is not a good one, because it means many things to many people. Willy Ley, the popular German-American chronicler of space travel, has gone so far as to deprecate the "dunderhead who thought the word 'crater' would be a . . . convenient name."

It has been too convenient. Craters on the moon are not necessarily the same species as craters on the earth. And yet there have been over 350 years worth of attempts to find proofs of sameness between the lunar and terrestrial versions.

The controversy over the origin of the great, depressed, circular structures on the moon raged almost from their discovery. In 1665, the versatile English physicist Robert Hooke compared them with two very different phenomena: depressions left by bubbles in boiling alabaster and impact scars left by bullets dropped into wet clay. He thereby set up the two essentially antithetical questions that have been argued ever since: are the craters of endogenic origin (depressions left by volcanic action) or exogenic origin (depressions left by impacts)?

In 1783 William Herschel, the English composer turned astronomer, thought he had witnessed volcanic eruptions on the moon, and since no one had been able to say where hypothetical impacting bodies could have come from, the arguments for volcanism on the moon remained convincing—for a while. Then, in 1803 came the great meteorite shower at Laigle, France. It forced the hitherto skeptical French Academy to admit that cosmic stones (meteorites) could indeed fall from the sky, and in 1829 the German astronomer Franz Gruithuisen went on to revive the impact theory to explain craters.

In the next several decades Hawaii received major attention because its volcanoes were easily accessible to investigators. Studies made there by two Americans, geologist J. D. Dana in 1846, and astronomer W. H. Pickering in 1906, led to comparisons of lunar craters with the terrestrial ones of known volcanic origin. But such comparisons ran into a profound difficulty. There was a discrepancy in scale between the vast circular structures of the moon, which range up to nearly 1,000 miles in diameter, and the largest known volcanic craters on earth, which are only a few miles across or, if less perfectly circular, a few tens of miles across.

In the meantime, modern lunar science was born—in an address on December 10, 1892, given by G. K. Gilbert, the retiring president of the Philosophical Society of Washington and first chief geologist of the U. S. Geological Survey. Along with other hypotheses, he proposed that while some of the smaller lunar craters might be analogous to extinct terrestrial volcanoes, the majority of the moon's larger craters were caused by the impact of "moonlets." These were supposed to have been orbiting the primordial earth during the early days of the earth–moon system.

Though many of Gilbert's suggestions were remarkably good, in terms of what we now know, little progress was made during the first half of the twentieth century. The controversy rolled on. It has been claimed, not entirely facetiously, that everyone was so anxious to be rid of the problem that astronomers tended toward geologic explanations while geologists invoked cosmic influences. Many of the best minds avoided the problem entirely, influenced by the nineteenth-century dictum that "the moon is dead."

In the 1950's, with the emergence of geophysics, space science, and a more cosmic perspective, a new interest arose in relationships between the earth and moon. Why do they appear so different? What are the craters? Why does the moon have so many more than the earth?

Let us look first at the earth. It has not yet been fully explored, a fact borne out by the discovery in the last decade of many of the great, ancient, circular scars in the earth's crust. Some of these "ring scars," including a number of circular lakes in the stable, billion-year-old Canadian Shield around Hudson's Bay, are considered to be the sites of meteorite impacts. Others, such as a series of eroded, forested, nearly hidden sites dotted across the eastern United States, and a number of vague, circular patterns photographed from high altitudes in unexplored parts of the world, may be endogenic and accordingly have been called "cryptovolcanic structures."

These discoveries have enlarged our frame of reference and strengthened our awareness that the earth has not escaped cratering. To be sure, the dis-

coveries did not solve the mystery of the lunar craters. but they did start us viewing the earth's surface in the context of the tremendous forces at play in the earth's interior and in the context of the cosmic interactions between the planets and their interplanetary environment. As a result, more and more geologists are turning to the other planets for a better understanding of our own. The evidence that these forces and interactions are frequent, and often spectacular, intensifies our interest in interplanetary comparisons and contrasts.

To begin with, both the moon and earth are some four billion years old. The moon is well preserved; the earth less so because it has been active. On the moon the four billion years production of craters (by whatever mechanism) has been preserved, but on the earth, the folding, rupturing, and eroding of the crust has erased the past.

If we could make a time-lapse film of the earth's surface with one frame representing every few million years, we would see a surface in chaos. New mountain belts rise up, volcanoes spout lava, great fissures open and widen, mountains wear away, coastlines change, and geologic structures are buried by sediments. As it is, we can see back only 10 million or 100 million years on most parts of the earth. Few new craters have formed on earth within this short time, while the older ones have been worn away. This explains the overabundance of craters on the moon relative to those on the earth.

But what of the craters we do find on earth? What kinds of structures are they? The question is becoming answerable in modern terms, thanks to recent and intensive research. The answer may prepare us for the findings when men reach other planets.

Although travel agents ignore them, the widely distributed craters of the earth are among nature's most spectacular creations. (The recent inauguration of direct and stopover flights to Hilo, Hawaii, allows travelers en route to Honolulu easy access to Hawaii Volcanoes National Park, a wonderland of scenic extremes otherwise missed by many islands visitors.) Few thrills in exploration exceed the reward one gets after climbing the innocent-looking rim of a large caldera. As you reach the top of what appears to be a low ridge, the ground suddenly drops away to reveal a vast, yawning pit at your feet. Scientifically, perhaps most fascinating is the variety of natural mechanisms that produce the depressions. Here are four volcanic types.

1. The buildup of ejected lava around a volcano leaves a raised rim surrounding the vent, which may be either open or covered. This well-known cross section can be seen in structures ranging from small *cinder cones* and *spatter cones* to great volcanoes such as Japan's Mount Fuji.

2. If the lava has collected below the ground in a chamber too big to support its own roof, fractures may develop, followed by collapse of the volcano. The resulting structures range from *collapse pits* to *calderas*, which may reach many tens of miles in diameter.

3. If the surface material is only loosely consolidated and the open chambers are not too deep (for example, if there are openings left by escaped lava) the material may drain into the cavity like sand in an hourglass. This produces *drainage craters*, relatively small structures up to several yards across.

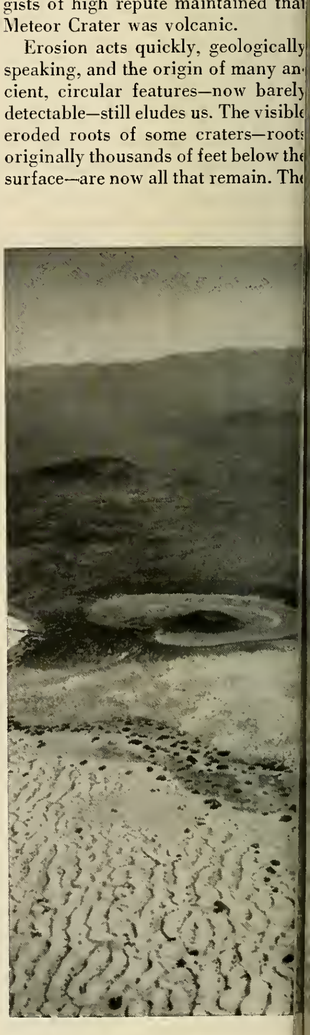
4. Sometimes, ground water gains access to the deep, hot magma chamber and makes contact with its lava. This produces great volumes of steam at high pressure, resulting in explosion-like eruptions. The craters created in such fashion have been given the name *maar* (after certain water-filled prototypes in Germany).

The above listing is of simple forms, which are produced only in ideal circumstances. In nature the history of a volcano is a complex thing. A rimless collapse pit may gain a rim through a subsequent eruption of debris. Erosion may intervene to change a vertical-walled, flat-floored pit into a bowl-shaped crater. This sort of erosion makes it particularly complicated to distinguish the earth's old volcanic craters from its old meteorite-impact craters.

The earth's meteorite craters result from chance collisions with the countless bits of cometary and asteroidal debris floating in interplanetary space. Most of the bits and pieces are so small and fragile that they burn up in the atmosphere, but occasionally a big one gets through to the ground—with results catastrophic by human standards.

In Arizona, Meteor Crater is an example. It was blasted out by a metallic chunk, perhaps a hundred feet in diameter, that plunged into the ground at nearly 6 miles per second. Nearly a mile across, this impact-explosion site is relatively fresh, yet it superficially resembles several nearby volcanic craters that have eroded. In fact, until meteorite fragments were identified here, several geologists of high repute maintained that Meteor Crater was volcanic.

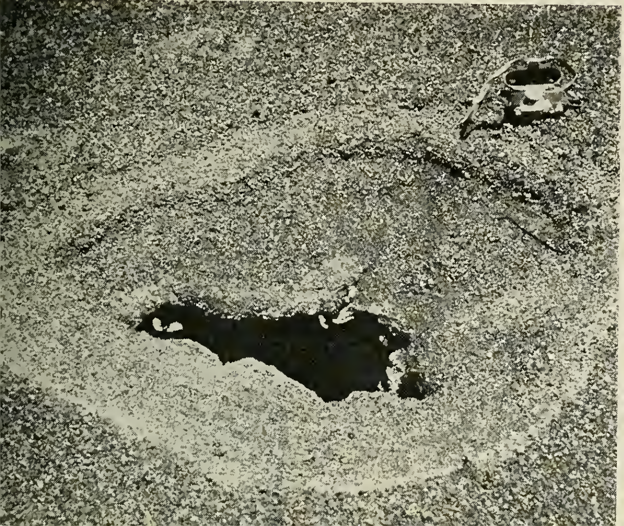
Erosion acts quickly, geologically speaking, and the origin of many ancient, circular features—now barely detectable—still eludes us. The visible eroded roots of some craters—roots originally thousands of feet below the surface—are now all that remain. The



earch for these "fossil craters" is a ascinating story by itself. Photo- raphs by astronauts in orbit have ırned up several new ones. One un- sual example is the Crooked Creek tructure in Missouri; it is most asily detected photographically in ıe fall because the colors of foliage t the ancient crater's rim are af- ected by soil differences.

Determining a crater's origin is also perplexing when the same evidence can apply to either impacts or volcanic eruptions. Both may eject rocks or unconsolidated clods of material, which, plunging into the ground, create secondary impact craters. In 1960, for example, the volcanic eruption that destroyed the village of Kapoho, Hawaii, went through a final stage in which it threw out rocks. These fell on a field of pumice laid down in a preceding stage, creating a remarkably lunar background for nearby orchid fields.

arth's craters run the gamut of sizes and types.
bove: small secondary pits and rocky debris form a moonlike scene ear a Hawaiian volcano. Left: Moon Crater, half a mile across, in volcanic complex just south of the Arizona-Mexico border. elow: a drainage crater, about one yard across; here dry olcanic cinders dropped into openings left by escaped lava.



By now, one can see that the comparison of lunar and terrestrial craters is complicated by the diversity of forms discovered on the earth alone. As if this weren't enough, the first close-up photographs of the moon, returned by spacecraft in 1964, revealed a puzzling lunar scene. To the dismay of scientists, the new clarity did not help diagnose structure by revealing outcrops of bedrock. Instead, two new phenomena were observed: the lunar surface was blanketed by a layer of fine debris, probably several yards deep, that hides the rock outcrops; and it is covered in abundance by a new type of small crater, very shallow and "soft-looking."

You may question now if there is any reliable way of solving the mystery of the origin of the planetary craters. Fortunately, some other observational methods have come to our aid.

First, we can study the rocks found near terrestrial craters. If they are volcanic rocks, they suggest that the craters, too, had a volcanic origin. On the other hand, the total absence of volcanic materials suggests a nonvolcanic origin for the crater. The evidence for an origin of the impact type is less definitive. If one finds actual meteorites nearby, that is a sure proof of meteorite origin, but there is a catch: an absence of meteorites proves nothing, because meteorites, especially the stony types, can vanish by weathering quickly. And this reminds us that some cosmic bodies, such as comets, may be mostly ice and leave no fragments at all.

Second, we are helped by the knowledge that meteorite impacts leave scars only in the surface layers of the earth, while volcanoes must have deep roots. Drilling has shown that many of the old crater-like depressions on the earth, such as the Canadian craters mentioned earlier, are only surface scars—fractures and broken rock are not found lower down. Their shallowness identifies them as meteorite craters.

Third, in the case of the moon, there is evidence that the formation of its craters required tremendous energy and the ejection of large

quantities of material at high velocities. We expect such phenomena when the moon is struck by medium-sized asteroids, but they are not consistent with any known volcanic processes.

Fourth, it appears that the number of lunar craters and their distribution by size are what one would expect if asteroidal fragments (meteorites) fell onto the moon. This supports the impact hypothesis.

Fifth, and finally, we should consider not only the earth and its moon, but the new data radioed back to us from another planet, Mars. The spacecraft Mariner IV revealed in July, 1965, that this "red" planet is peppered with craters. So numerous and large are they that Mars resembles the moon more closely than it does the earth. This finding was important in two respects. It confirms that because Mars has a scant atmosphere and little erosion, its ancient craters would be better preserved than those on earth. It also makes sense because Mars is near the asteroid belt, so it should have been struck by asteroid debris if any planet was. Because the Martian craters, like the lunar ones, agree in number and size distribution with the predictions of the asteroid impact hypothesis, this discovery suggests that all three planetary bodies have been struck by interplanetary debris.

If this tips the scales toward the view that most large planetary craters resulted from asteroid impacts, we must remember that a planet is a many-splendored thing. Its surface may have been changed both by impacts and volcanism. Inasmuch as we know the earth bears the scars of volcanism, why not the moon and Mars too? The fact is that volcanism is not unique to the earth—it must occur in some form as an evolving planet releases its pent-up gases. Planets, which we should like to think of as stable "platforms," actually are heated by radioactivity and then eventually cool off. Volcanism is a by-product of this evolution; the telltale fracture patterns and lava flows of the moon are mute evidence that the process has occurred there. Hence, we expect to find volcanic pits there. On the moon, the most likely candidates are the "chains" of craters, usually a few miles in diameter, lying in long, straight rows that mark faults or deep fractures of this satellite's surface.

As for Mars, the photos from that planet are not yet good enough for us to pick out clear examples of volcanism. We can see only the craters we attribute to asteroids. But volcanic pits may well be there—it is now regarded as naïve to suppose that all the craters of any planet are of a single origin.

What about other questions? The small "soft" lunar craters discovered by the Ranger spacecraft are still a mystery. The best we can do is choose between two current hypotheses. They are either collapse depressions of internal origin or old impact craters eroded by the constant rain of small meteorites. In other words, the exogenic–endogenic battle is still being waged over the moon's small-scale features, and we may have to wait for the first lunar astronauts to tell us what they find in and under these curious small bowls.

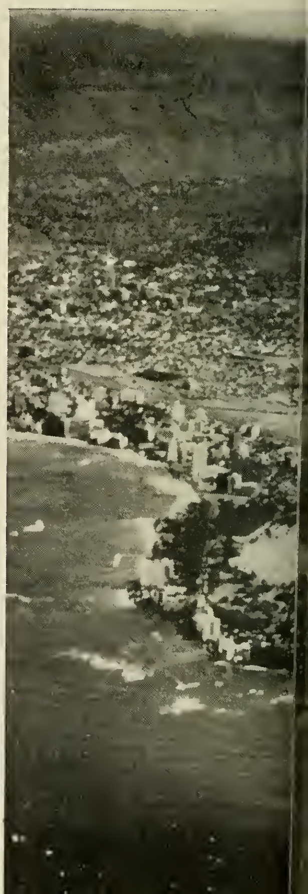
So far, I have referred casually to interplanetary interlopers that occasionally crash into the planets and leave large ring scars; also, comets and asteroid fragments have been mentioned only incidentally. Is more known about such invaders?

Four to five billion years ago, during the beginning of the solar system, it is supposed to have contained small bodies, newly formed from the interstellar dust and gas. Some of these planetesimals, as they are called, grew into planets—perhaps by coalescing. Of the remainder, some may have then collided with the young planets to produce the oldest craters we see. Still others escaped to the outer reaches of the solar system, returning only occasionally to the inner neighborhood of the sun, where we see them as comets.

In addition, the planetesimals between Mars and Jupiter apparently never coalesced into a single planet. We believe that collisions between them chipped off the countless fragments that comprise what we call the asteroid belt. Occasionally, some of these stony and iron fragments may be knocked clear out of their orbits to drift on a new orbit in the solar system. They may then collide with a planet. Those we see striking the earth are called meteorites. In any case, it is sensible to believe that comets and asteroid fragments alike have been striking the planets during most of our solar system's history, long after most of the original planetesimals disappeared.

Thus, on at least three planets, and probably on many others we have not yet explored, nature has created circular pits—craters—by grossly different mechanisms: by impacts and volcanic activity of various kinds.

In sum, nature has a way of appearing more complicated, and yet more understandable too, than we expect at first examination. If such varied types of craters are more understandable today than they were a decade ago, it is because, curiously enough, we have turned our gaze from the ground to learn from other lands far away in the sky.



lcanic craters and cinder cones dominate the primordial-looking landscape, above, near San Francisco
aks, Arizona. In contrast, Honolulu's famed landmark, Diamond Head, is a crater within a city.

Books in Review

A Difficult Pill to Swallow

by David Hawkins

The Ghost in the Machine, by Arthur Koestler. *The Macmillan Co., $6.95; 384 pp., illus.*

Arthur Koestler's earlier writings have managed to stir controversy, and this book is likely to fit the same pattern. Among its recent predecessors, *The Sleepwalkers*, a history of early modern astronomy, received some scholarly rebukes amid a wider enthusiasm. *The Act of Creation* gave rise to a certain agitation among the psychologists, and again received a high general commendation. I propose to respond to the present work in lower key.

The book is an essay within a context. The essay is concerned with man's unique and powerful destructive tendency, which our generation has armed with weapons that might give it global expression. Koestler proposes an explanation of what Hegel called "the slaughter-bench of history," and offers a hope for radical amelioration, though not of cure. The explanation is a hypothesis about the nature and evolution of the human nervous system. The treatment is a hoped-for product of future research in psychopharmacology, what a publisher's blurb calls a "peace pill." To build a context for his argument Koestler starts back several steps; the first two of the book's three parts are a connected series of essays on the foundations of psychology, the principles of evolution, and human creativity.

A good deal of the exposition and argument in the first two-thirds of the book lacks direct relevance to the final thesis. But this can be justified: first, it is an excellent synoptic discussion, in its own right, of important and fascinating matters. Second, what is not directly relevant to the thesis is necessary, I think, to establish the philosophical and moral position, the *bona fides*, of an eminent humanist who is about to propose to modify the human condition through biological engineering, and a "pill" at that.

A good deal of the first part of the book is devoted to an exposition of the concept of hierarchical organization living systems, as opposed to older b still-dominant concepts of mechanis enchainment. For polemical spice the is much lively and well-informed cri cism of neobehaviorism in psycholo which Koestler finds to be anything b a dead horse. Here he is representi not only the informed passions of t humanist but also the best work of n rophysiologists and hardware-mind cybemeticians, three groups who ha far more in common than may app at first sight. To get to the place wh such a trinity does not seem unholy, even strange, is part of the philosop task. The history of science—even biology—is beginning to outgrow old, mechanistic scheme, and there i new metaphysics implicit in the gr ing sciences of organization and formation, equally remote from stin lus–response psychology and from dualism of Descartes. Indeed, in a la chapter Koestler takes on the mi body problem, from which the b draws its title. Within the concept of a hierarchical organization of hun mental processes there is possibl functional significance for conscio ness quite different from what is av able to older ways of thought.

I will mention some negatives don't think Koestler understands ideas of thermodynamics, or the s ond law. This law is not contravened the organizational and integrat tendencies of living matter, but the contrary provides, from the ph cist's point of view, the indispensa framework for the very principles hierarchical organization that Koes is espousing. And I think this sa weakness crops up again in his tr ment of the alleged inadequacy of mechanism of random mutation as primary source of genetic variat Typically the critics of evolution theory, and sometimes its suppor too, have vulgarized it by forget that even in the simplest versions Darwinism it is not "chance variati that imports new organization into

handful of people like Mary Carnwath
e trying to keep our promise to the Indians.
it they won't make it without you.

ne Hopi Indians' village of ulovi in Arizona sits on land or, infertile and inhospitable o far nobody has tried to take y from them.

ectricity has not yet reached lopis. Water must be hauled three miles away. Jobs are few ar away. Only poverty and des- re close-by and in abundance.

et for the first time in genera- Mary Carnwath and people er are stirring hope among the .

lary Carnwath works and two thousand miles away, in attan. Her own daughter is grown-up, and through *Save hildren Federation* she is spon- one of the village girls, 8-year- race Mahtewa.

he Mahtewas (two parents, children, one grandmother sister-in-law) live tightly d in a tiny rock and mud . The father who knows ranch but can't find any most of the sn't able to provide the family even the bare necessities.

Grace, bright, ambitious and industrious, would possibly have had to quit school as soon as she was old enough to do a day's work. But, because of Mary vath, that won't be necessary.

he $15.00 a month contrib- by Mary Carnwath is provid- remarkable number of things race and her family.

race will have a chance to con- schooling. The family has able to make its home a little livable. And with the money ver, together with funds from sponsors, the village has been o renovate a dilapidated build- r use as a village center. The now has two manual sewing nes that are the beginnings of ll income-producing business. nly a small beginning. More y and more people like Mary vath are needed. With your perhaps this village program will produce enough money to end the Hopi's need for help. That is what Save the Children is all about.

Although contributions are deductible, it's not a charity. The aim is not merely to buy one child a few hot meals, a warm coat and a new pair of shoes. Instead, your contribution is used to give the child, the family and the village a little boost that may be all they need to start helping themselves.

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stream of life, but its correlative in the theory, "selection." Koestler can't quite resist this literary device, as when in his summary on evolution he refers to some supposed orthodox view "that evolution is the product of blind chance." Actually much of the evidence that Koestler cites points toward "selection" as the crucial concept, as he part of the time sees. The main troubles with evolutionary thought have not lain in the conception of chance variation, but in the way selection has been understood. Indeed our understanding of natural selection can be no better than our general understanding of biological systems *and* the environments in which they in fact evolved. A good deal of what is said here reflects recent illumination on the former of these topics. The latter, opened up by Oparin, Horowitz, and others, is missing.

Coming closer to the main theme, we move into the theory of emotion and of its functional role in human conduct. At once the apex of an organismic hierarchy and a component of a large social hierarchy, the human individual can only exist stably through a balance of integrative and self-assertive tendencies and of the kinds of emotional charge that they imply. In the wide pathology of human aberrations from this necessary flexible balance, Koestler finds one that is responsible, above all, for the trouble that is human history. This aberration is not a dominance of aggressive over integrative tendencies, but quite the contrary. The need to sublimate aggressive impulses in the interests of social existence is widely recognized throughout history, and has, at least crudely, been satisfied in the main. The weakness to which man is endemically prone, and for which he apparently lacks adequate remedies, is his tendency to fall under the domination of integrative or self-transcending emotions in an essentially infantile way. Identification with group or cause may thus serve as the vehicle for emotions of the opposite class. Threats to collectively shared systems of belief are reacted to as threats to personal survival. When this happens the integrative tendencies that normally limit aggression are leagued with it instead, and the result is rather predictably a fratricidal explosion.

This is the disease, or more properly the defect, responsible for the self-destructiveness of human society. It is Koestler's hypothesis that this defect is the expression of a functional weakness in the human nervous system, a failure of integration between the "old brain," the limbic system that we have received and adapted from our reptile and early mammal ancestors, and the "new brain," the neocortex. The malintegration of emotion and reason in a man's life thus appears as the expression of a corresponding failure of integration within the nervous system. This is the part of the book by which its author would, I suppose, set the greatest store, and the one from which emerges his rather tenuous suggestion of help from chemical medicine. He is quick to disclaim the belief that mere molecules, however elaborately tailored, can provide for integration within a brain deficient by intrinsic organization. But he does propose that by such means the integrative capacities we have could be protected and enhanced.

The more important question, I think, is the legitimacy of the belief that we humans suffer from a congenital defect of character, whatever its origin, and if so, whether Koestler's description of it is correct. At the core of his diagnosis is a mechanism that allows a system of beliefs to be substituted for the living human being so that when threatened, this system has highest priority over all resources at the organism's command. Such beliefs, tied to specific modes of action and perception in hierarchical organization, are not merely abstract propositions assented to, but express to the believer the very framework of a reality in and through which he lives; what is called in Spanish his *manera de ser,* his way of being and not just his way of happening to believe. The important questions, it seems to me, have to do with the ways in which we develop such belief systems and the ways in which we learn, more successfully or less successfully, to revise and reconstruct them in the light of ongoing experience. A pathologically closed system of beliefs is one that is protected from growth by incapacity to accept, acknowledge, or know what to do with information at variance with that system. And this is where I find Koestler's treatment radically inadequate.

Here I am not finding fault with the rounding up of evidence, nor with the wide apperceptive background and *bona fides* necessary to the discussion of such grave matters as this book is concerned with. What I miss is the sense and sensitivity cultivated in a long tradition of concern for the nurture of human development and for the ways in which this development can be furthered or deeply damaged in early life and education. Here surely lies the most obvious alternative to Koestler's whole line of approach: that the etiology of our woes lies, not in the domain of biological evolution, but in that of cultural evolution—our failure to provide that habitat for the human child that allows him to learn in practice, and to practice in learning, those habits, strategies, and modes of percep-

tion that are necessary to the stability and autonomy of adult life.

Of course it need not be either—or. We will all surely support the demand for wider and deeper research in neuropsychology and its linkage to the sister sciences of organization and information. But I think we ought also to be disconcerted by a book with such power and breadth of thought in these areas that defers nothing, even by way of counterargument, to the potentialities of wider and deeper research in education. This is or should be central among the same sorority of sciences. I do not require that Koestler discuss the great tradition of Plato and Rousseau. But I wonder whether he is even aware of not discussing it.

David Hawkins is Professor of Philosophy at the University of Colorado, where he is also Director of the Elementary Science Advisory Center.

The Great Monkey Trial, by L. Sprague de Camp. *Doubleday & Co., $6.95; 538 pp., illus.*

There are many ways in which older members of the Social Security set, or their curious juniors, may recapture the spirit of the 1920's. They may recall keeping cool with Coolidge, or the taste of bathtub gin, dancing the Charleston, the hope of making millions in Miami, the excitement over the Floyd Collins case, the recollection of daring songs whose lyrics dealt candidly, as the social historian Mark Sullivan wrote, with the "cosmic urge in the animal species below the primates." But no event typed the period more faithfully than the judicial proceeding in which John Thomas Scopes, a Tennessee biology teacher, was found guilty of violating a loosely drawn anti-evolution statute that nobody ever thought would be enforced. In *The Great Monkey Trial*, L. Sprague de Camp has provided a full and absorbing account of what actually happened at Dayton, Tennessee, with all of the ironies and oddities of the trial, its circus atmosphere, its moments of comedy, melodrama, and farce. The author has enriched his account of the immediate event by relating it to the broader social situation and keeping in steady view, along with the fun and games, the genuine significance of the proceedings held at the Rhea County courthouse during July, 1925.

Mr. de Camp's narrative abounds in surprises. The whole idea of the trial was hatched by men with no serious interest in the issues, partly as an antic, in part as a ballyhoo to attract attention to little Dayton, set in the strawberry fields of southern Tennessee. The defense hoped to lose their case, since their object was not to vindicate Scopes but to take the constitutional issue to

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THE PROPOSITION WOULD GET A LOT OF SUPPORT IF THE MONKEYS COULD VOTE ON IT
—Orr in the Chicago *Tribune*.

the higher courts. Meanwhile, rural Americans rallied in defense of Bible literalism behind William Jennings Bryan, chief counsel for the prosecution. Clarence Darrow led the defense. Support for thought control came from fundamentalist leaders all over the United States, from "Billy" Sunday in Oregon, from Aimee Semple McPherson and "Fighting Bob" Shuler in California. Dr. Gerald B. Winrod, later a fascist and Ku Kluxer, sent encouragement from Kansas, and the scientific validity of Genesis was trumpeted by the Rev. John Roach Stratton of New York, ancient foe of The American Museum of Natural History because it attached undue significance to "musty old bones" and supported "false and bestial theories."

Although evolution had long before passed into the general stock of ideas held by educated men, the fury aroused by the trial demonstrates how slight the penetration had been into those areas of American life devoted to long underwear, the Saturday-night bath, and the old-time religion. Bryan took the witness stand as a Bible expert, was ruthlessly exposed as an intellectual incompetent by Darrow, and died a few days later of fatigue, heat, pique, and diabetes. Scopes was convicted and fined, while the law remained on the books until 1967 with no further effort to enforce it, and high school students of the Volunteer State read without harm the section on evolution in Otto and Towle's *Modern Biology*. Mr. de Camp makes the issues clear, corrects a number of errors, and although he is on the side of the angels (i.e., the monkeys, as well as the tadpoles, which lose their tails even in Tennessee), he is scrupulously fair to all.

GERALD CARSON
Author

GLUTTONS AND LIBERTINES, by Marston Bates. *Random House, $5.95; 244 pp.*

Is it natural to sleep in a bed, to wear a nightshirt, to be monogamous, to eat bread? Or in a hammock, nude, among several wives, and eat ants and lizards? After living in various parts of Latin America, Albania, and the South Pacific, as well as in the United States, Marston Bates seems convinced that customs make prisoners of people. He questions at length what we do and say, trying to distinguish cultural habits that still have survival value from those that could better be cast aside.

In many ways, Bates's book is strictly contemporary. It could not have been written as it is, in language or content, a decade or two ago. Today's

readers are willing to consider an irreverent analysis of ideas about man and nature. And a vast amount of fresh information has become available recently on the habits of wild primates—gorillas, chimpanzees, howler monkeys, and others—as a background against which man's antics and attitudes can be examined. This comparative approach appeals strongly to Bates, the professional zoologist. He sees in it a criterion for distinguishing what is natural and what is unnatural in modern culture. There is no question about his personal preference for the natural, or his recognition that being natural can be unsettling to many people.

One proposal central to this book is that customs relating to food have many counterparts among customs relating to sex. The rules about eating one's neighbor (cannibalism) seem remarkably similar to those about marrying near kin (incest). In exploring the parallels and contrasts, Bates arouses the reader much as he did in his previous and somehow similar book *The Forest and the Sea,* where the stratification in a tropical rain forest was compared with that in a tropical coral reef. A difference between the earlier book and the new one lies in the fact that extremes in stratification were good for evolutionary progress, whereas extremes in use of food among gluttons and of sex among libertines are generally regarded as bad.

While focusing attention upon undesirable behavior, the author points out that non-human primates behave unnaturally and badly only when confined to a zoo. He suggests that human meanness—aggression—is also a consequence of being confined. If so, the more prevalent people get, the meaner and less natural they are likely to become. Something drastic must be done before natural ways disappear altogether and aggressive behavior is assumed to be normal for the human species.

As Bates expands his thoughts, with many a lively side trip to the unabridged dictionary and frequent reference to books he has found provocative, he touches on many fields but comes to the conclusion that "this whole book is a plea for tolerance of diversity. Diversity seems to me a good in itself. I can justify this in biological terms: the most stable biological communities are those with the greatest variety of organisms. Diversity means that if something happens to one kind of animal or plant, others are present to take over; there is a great deal of 'play' in the system. . . . The same argument applies to human economy: the more diversified the economy, the safer it is from disaster because of accident to one crop or one industry."

So far as he can see, culture is increasingly artificial, in danger of swamping mankind as well as all other forms of life.

Lorus and Margery Milne
University of New Hampshire

Indian Art in South America, by Frederick J. Dockstader. *New York Graphic Society, $27.50; 222 pp., illus.*

This is the companion volume to Frederick Dockstader's two earlier works on the native arts and crafts of North and Middle America. Together, the three books constitute what is probably the single most comprehensive survey of native American art.

Indian Art in South America is published by the New York Graphic Society, which has come to mean that the book contains a large number of high-quality illustrations. This one has 250 photographs of pre-Columbian and contemporary art objects. Most, if not all, of the illustrated pieces have not appeared in other published collections of American art. There are two hundred photographs of archeological specimens, mostly pottery vessels but also some jewelry and textiles. These come from all parts of the continent and show clearly that esthetically pleasing arts and crafts were not limited just to the central Andean area. The remaining illustrations are of contemporary art objects, most of which were manufactured during the past century and come from the eastern lowlands of South America. The illustrations are uniformly clear and of high quality; however, on a few of the color photographs with blue backgrounds (for example, the Nasca pot in fig. 133) the red pigments appear to be too vivid or intense.

Each illustration is numbered and accompanied by a brief description of the object, as well as information about its provenience, age, cultural or tribal affiliation, and present location. Of particular interest to the professional archeologist are the two Santa Ana pottery vessels found near Trujillo, Venezuela, which are said to have come from the same burial cave; these are important because very few specimens with archeological associations indicating that they were used at the same time have been reported from the northern part of South America.

A 31-page introduction provides some perspective for looking at the illustrated specimens. This commentary includes brief statements about the geography of South America and the culture history of its native peoples. The maps accompanying the introduction show the locations of places or cultures mentioned in the text or the captions; these are occasionally mis-

leading or in error. The chart showing the chronological relationships of the archeological cultures mentioned is confusing and out of date; it reflects what was thought about a decade ago and does not incorporate many recent developments in South American archeology. These deficiencies are more than offset by the extensive bibliography, which will guide the reader through the recent technical literature.

The book is not only interesting but also useful, and the author should be congratulated for the high quality of this work.

THOMAS C. PATTERSON
Harvard University

THE DANCE LANGUAGE AND ORIENTATION OF BEES, by Karl von Frisch. *The Belnap Press of Harvard University Press, $15.00; 566 pp., illus.*

Do bees have a language? That word, "language," must not be misunderstood, points out Professor von Frisch. He uses the term to emphasize "what is extraordinary in the realm of animal behavior." Honeybees do have a language. Their systems of motions, movements, sounds, and complexes of these, convey definite meanings; the carefully documented 566-page book attests to this.

Neophytes in the ways and habits of honeybees, and those who wish to see and duplicate the remarkable experiments performed by von Frisch, will find the twenty-one pages devoted to methods very useful. A simple observation hive is both described and illustrated. Methods of marking, grasping, moving, photographing, and manipulating colonies for scientific purposes are clearly shown.

The longest chapter discusses the tail-wagging dance. The chapter begins with a simple explanation of the dance, followed by the long series of experiments that have led to our present-day knowledge. For example, how does the wind affect the tempo of the dance? A headwind, on the way to the food source, slows the dance, acting the same as does increasing the distance. Conversely, a tailwind increases the tempo of the dance. Experiments were done in both high and low wind velocities, again attesting to the thoroughness of the observations.

A six-page chapter is devoted to other honeybee dances. While these are clearly described, it is pointed out that their function is either obscure or unknown. Thus does Professor von Frisch point to future studies.

While other social insects, the termites, ants, and wasps, probably have equally complicated communication systems, these insects hide their nests, and it is difficult to study them. They

will remain little known for some time. Sociologists, zoologists, even philosophers interested in the formation of societies have long made use of certain of the von Frisch papers in their lectures and writings. Unfortunately, only a few of von Frisch's papers, and those of his students, have been translated into English. Many of his early papers are obscure, and most of his work on odors and their role in honeybee communication is little known in the English-speaking world. This book will serve to improve many lectures and to clarify certain misunderstandings and voids in the minds of those not thoroughly familiar with the literature.

A scientist can make errors. Professor von Frisch illustrates this in his historical introduction. When he first started to work with honeybees he thought that the round dance indicated a source of sugar water or nectar, while the tail-wagging dance indicated a source of pollen. Such is not the case, and patient research showed that the type of dance performed had to do with the distance of the food—whatever it might be—from the hive. However, in this brief, but complete, admission lies the secret of true research.

While the book was written by von Frisch, it is a compilation of all that he and more than forty students, and certain of their students, have done over the years. Additionally, research from other parts of the globe is discussed where it has application.

The most valuable portions of the book are the interspersed summaries, where the facts are refined and carefully stated so that the reader has no trouble understanding what is meant.

Regrettably, the English is not quite as good as it might have been. However, I have not found any words or selections that were not fully understandable upon a second reading; it might be fairer to the translator to admit that German is not an easy language to translate.

The work of Professor von Frisch has long been a model in the biological sciences. That he has condensed his knowledge and findings, together with those of others, into one well-planned volume sets an even higher standard. It is a guideline for others.

Roger A. Morse
Cornell University

Hill Country Harvest, By Hal Borland. *J. B. Lippincott Co., $5.95; 377 pp.*

In the course of a specimen year Hal Borland's harvest in *Hill Country Harvest* is too varied to be summarized in a short review. He lives in Connecticut, close to the Housatonic River. For years he has been writing about

that natural environment with knowledge, flavor, and love. All he asks is to be permitted to make the rounds of the seasons. "Someone finds out something new about it every day," he says. He is his own best example.

Every now and then Mr. Borland does state a policy. I should like to express particular satisfaction with his policy of letting things alone—the first principle of enlightened conservation. When he bought his farm years ago he decided not to "improve" the woodlot on the mountain. Experienced people have been advising him how to cultivate it by any one of several recognized practices. By letting it alone Mr. Borland has acquired a growing, spreading forest of evergreens and hardwoods, and the two springs flow better than they used to. "I think I was right to let those woods alone," he says, and I agree with him.

A high school teacher, put in charge of a ten-acre lot of land donated to the school, asked Mr. Borland how to develop it. Mr. Borland replied: "Leave it alone and watch what happens"—sovereign advice that he knows any school committee would be too impatient to accept. "You have to leave it alone, keep human interference at a minimum," Mr. Borland declared. He is delighted to see the word "environment" become a standard part of the planners' vocabulary. But he suspects that planners expect to level hills and drain swamps in their programs of preservation of the natural environment. Mr. Borland is so passionately committed to the policy of submission to the processes of nature that he refused to improve an old sway-backed barn until the doors fell off. I regret the new doors. Made of new lumber, they must look hideous.

"Studied neglect" is the sardonic phrase he uses to express his principle. He has a garden and orchard that have to be cultivated. If he has hayfields, they have to be fertilized and plowed up every few years. But he is right to let the trees in his woodlot find their own natural place in the scheme of things. In a technological civilization like ours it takes great strength of mind to do nothing.

P.S. But keep on writing books about it, Mr. Borland. Keep on doing something for your readers.

BROOKS ATKINSON
Author and Critic

Briefly Noted

A FIELD GUIDE TO WILDFLOWERS OF NORTHEASTERN AND NORTH-CENTRAL NORTH AMERICA, by Roger Tory Peterson and Margaret McKenny. *Houghton Mifflin Co., $4.95; 420 pp., illus.*

Roger Tory Peterson has provided a welcome addition to his "Field Guide" series with this new volume.

;ased upon his own system of identi-cation—one of visual impressions, uch as colors, general shapes, and istinctions between similar species, ather than technical features—the ook offers beginners an easy picture-iatching method for recognizing flow-rs. Unlike the usual botany book, this uide is not arranged in the traditional rder of plant relationships but is ivided into six main color sections. ield marks can be easily recognized i the numerous color and black-and-hite plates. A brief analysis of each imily is also included.

HE WEST OF ALFRED JACOB MILLER 1837), by Alfred Jacob Miller. *The 'niversity of Oklahoma Press, $15; 08 pp., illus.*

For all those interested in the Far Vest of the Plains Indians and the ountain men, this should be a valued iece of Americana. Miller was an art-t who, in 1837, accompanied an ex-edition to the Rockies to "sketch the emarkable scenery & incidents of the ourney." The book includes some 200 atercolors and on-the-spot sketches f the West before civilization—the ndscape of the Rockies, the Indians, ie buffalo hunts, and the fur trappers' imps. The artist's descriptive notes rovide background material for the enes he depicted. C. B.

his list details the photographer or her source of illustrations, by page.

VER: Patricia Caulfield
-Philip Gendreau
-L. David Mech
-Lee Boltin
-29—Charles Krug
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of California
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37—French Government
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39-41—C. Loring Brace
42-45—AMNH
47-55—Patricia Caulfield
57—Helmut Wimmer
58—top, Litton Indus-
tries, Aero Service
Division; bottom, left
and right—NASA
60-63—William K.
Hartmann
68—Chicago Tribune

Suggested Additional Reading

THE COMING FAMINE

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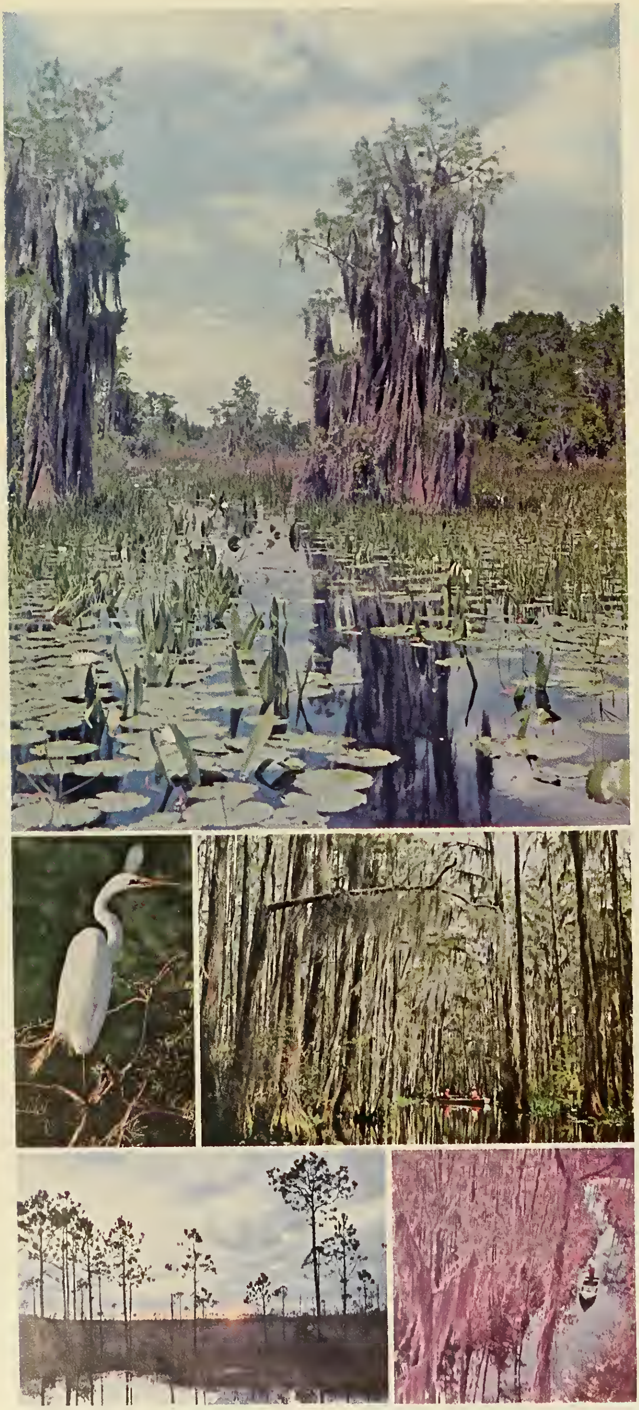

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Natural History

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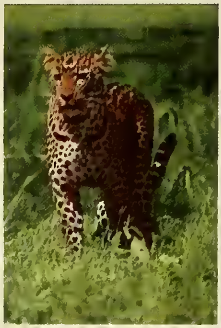
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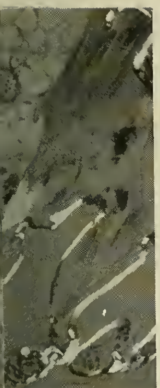
Natural History

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

VOL. LXXVII No. 6 June-July 1968



DEPARTMENTS

The American Museum is open to the public without charge every day during the year. Your support, through membership and contributions, helps make this possible. The Museum is equally in need of support for all of its work in the fields of research, education, and exhibition.

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Joseph A. Towles

Colin M. Turnbull

Michael J. Harner

Leslie C. Crine

Alfredo MacKenney

David H. Stone

Richard M. Romin

Henry M. Rubin

THE AUTHORS

Joseph A. Towles, coauthor with Colin Turnbull of the article on violence, will receive a B.A. in anthropology from Pace College this month. Born in Virginia, Mr. Towles spent a year and a half studying and doing field work at Makerere University College in Uganda. He has worked as research assistant to Dr. Turnbull.

Colin M. Turnbull, Associate Curator of African Ethnology at The American Museum of Natural History, was born in London and educated at Oxford, where he studied philosophy, politics, and later, anthropology, specializing in the African field. He has published *The Forest People*, *The Lonely African*, and *Wayward Servants*, all drawn from three extended field trips to Africa, and has just finished supervising the Museum's new Man in Africa Hall, which opened early this month.

Michael J. Harner's major area of anthropological field work has been in the Upper Amazon Basin, where he spent two years with the headhunting Jívaro Indians of eastern Ecuador and two more with the Conibo Indians of eastern Peru. After receiving his Ph.D. in anthropology from the University of California at Berkeley, his intense interest in the role of hallucinogens in the supernatural life of the Jívaro took him back to that tribe for another year of field work. Dr. Harner is a Visiting Associate Professor of Anthropology at Columbia University, and is currently working on an ethnography of the Jívaro.

Grand Prize winner of Natural History's photo contest, Leslie C. Crine from Port Jervis, N. Y., works as a brakeman on the Erie-Lackawanna Railroad. He began photographing nature subjects to show to his invalid father and at that time, he says, "I became conscious of the ever-changing world around me." His winning picture is the first he has ever entered in a contest.

Alfredo MacKenney, a doctor in Guatemala City, combined his interests in mountain climbing and photography to get his First Prize color shot of the volcano Pacaya erupting.

English-born David H. Stone (First Prize, black and white) i chemical engineer in Dartmou Nova Scotia. A keen naturalist, finds most of his subject matter o doors. He has won several previ awards.

Miriam Rothschild is a meml of the famous English banking f ily, many of whom were avid natu ists. She was educated at home managed to avoid the public exa nations she so deplores in her arti She has published over a hund papers on subjects from parasitol to gigantism in winkles, and her a cle on mimicry in nature appea in Natural History in Februa 1967. Her recent work has b mostly with fleas, and she is curre preparing "a massive tome" on th histology. She reports that on the casion of her being made an Hon ary Doctor of Science by the Univ sity of Oxford, she was introduce "The Queen of the Fleas."

Meteorological studies at the Force Weather Technical School three years' experience as a weat observer led to Richard M. Rom article on cloud watching. A na of Philadelphia, Pa., he was no nated as a President's Scholar Temple University, where he will ceive a B.S. in journalism this mo Mr. Romin wrote "Substitute Pa a piece about a guard at the Phila phia Zoo, which appeared in *To* magazine, and has done several f lance articles. He is a membe Sigma Delta Chi, the professi journalistic society and says he i dilettante painter and a frustr poet."

This month's article on wine c from Henry M. Rubin, whose we column, "The Winemaster," in *San Francisco Chronicle* cover range from "apéritifs to zinfande wine economics, vintage reports, new wines. He is writing a cookb on soups, based on the cuisine of own restaurant, the Pot Luck Berkeley, Calif., which claims a lating menu of 300 soups and most extensive list of Califo wines in the world. Mr. Rubin is owner of a small château in Medoc region of Bordeaux and p to be there in the fall for the vint

he Hasselblad System...
nd why a certain kind of person might fall in love with it.

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And that's what the Hasselblad is. The best designed and built camera in the world.

Many people have bought a Hasselblad after just holding one in their hands for a couple of minutes. They seem to know instinctively that it will take great photographs. And, if even further proof is needed, not only has a Hasselblad been carried on every NASA space flight, but more top professional photographers use Hasselblad than any other camera in the world.

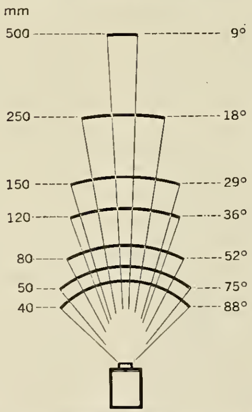
The basic Hasselblad camera is really just part of a completely integrated and interchangeable system of camera bodies, film magazines, lenses and accessories.

The film format used in the Hasselblad System is 2¼" square. This has been described as the "ideal" format, and with good reascn. It's big enough to give you pictures of superb quality and definition, and yet small enough to allow the design and physical shape of the camera to be as compact as it is.

The Hasselblad uses the single lens reflex viewing system. The beauty of this method is that you see the object you are going to photograph on a large 2¼" square ground glass viewing screen, as you look through the actual lens that will take the picture, so you always know exactly how your finished picture will turn out.

There are three bodies in the Hasselblad System, each one designed and constructed to perform its own particular function better than any other camera of its type.

Firstly, the 500C. This could almost be called the "workhorse" of the Hasselblad System. It is the standard body in the System and takes all the lenses and magazines that are available for the Hasselblad. No single camera has been used and praised more by the top professional and amateur photographers than the 500C. The other two bodies are more "special purpose" cameras. The 500EL, which is an electrically driven camera allowing for rapid exposures and remote control, and the Superwide C wide angle camera. No other camera using the 2¼" square format has as wide an angle of view as the Superwide C. On its introduction, this camera was hailed as a breakthrough in camera design. There are seven lenses



Interchangeable Lenses. This diagram illustrates the focal length (l.) and the angle of view (r.) of the seven lenses available in the Hasselblad System.

in the Hasselblad System, all by Carl Zeiss, makers of superb quality optical glass for generations. The lenses range from a 40mm wide angle, to a 500mm telephoto. Every lens has a built in Synchro Compur shutter with provision for flash and strobe synchronization at all 10 shutter speeds, from 1/500 of a second to 1 second.

One of the most striking features of the Hasselblad System is the interchangeable film magazines, each one of superb design and construction. The beauty of these magazines is that with just one camera body, a photographer can shoot pictures in black and white. Then, before finishing the roll, change to a magazine loaded with color, shoot a few color shots, then go back to black and white film. One magazine even allows you to make 70 exposures on one roll of film. Hasselblad was the first camera system to offer the advantage of interchangeable magazines.

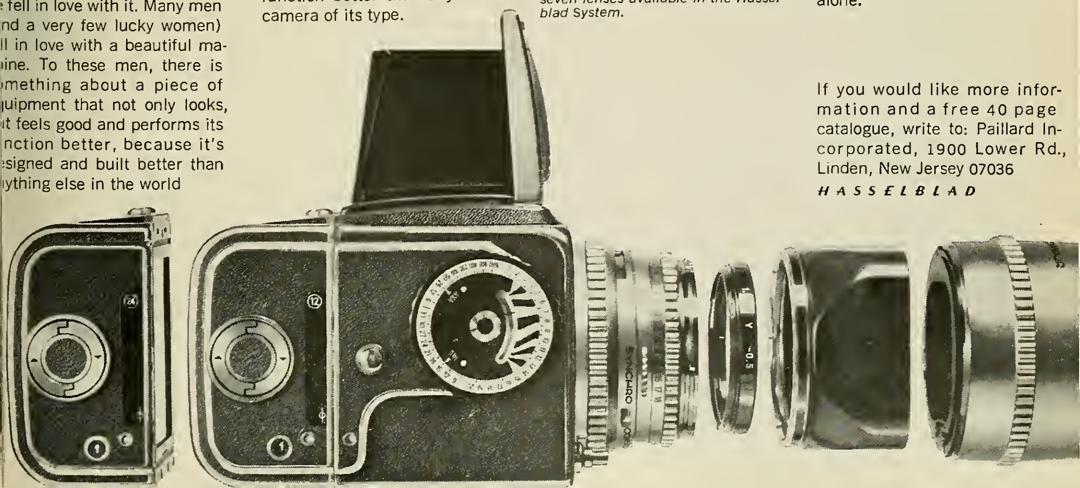
There are many many accessories in the Hasselblad System, each one designed and built to the same extreme standards of quality and craftsmanship that Hasselblad has become famous for.

Shown below are just a few items in the System.

Like all good things in life, the Hasselblad is expensive, but if you're the kind of person we have been talking about (and you wouldn't have read this far if you weren't) then, who knows, with this kind of camera, perhaps you could live on love alone.

If you would like more information and a free 40 page catalogue, write to: Paillard Incorporated, 1900 Lower Rd., Linden, New Jersey 07036

H A S S E L B L A D



The Wh

by Joseph A.

The racial problem in our country concerns both blacks and whites, but its cause, and the only hope for a peaceful solution, lies mainly in the hands of the whites, and in that sense it is finally their problem.

The problem is rooted in the slave system, which defined and circumscribed the status of the Negro, a system from which whites derived a consensus of attitudes about the Negro. Ultimately the notions of this system were to spread throughout the nation, and long after the system itself was destroyed values originating within it continued to be the guidelines that defined the attitudes of white Americans. Thus, the problem of whites today is to come to grips with their underlying racist notions, for the present status of the Negro is a direct outgrowth and manifestation of an underlying assumption of white American superiority.

The first essential then is a radical reversal of the complacency that has characterized white attitudes, articulated as "the Negro problem." In assessing the present situation as the work of a "few agitators" or part of a "communist-inspired" conspiracy it is assumed that the solution lies in the Negroes being "law-abiding citizens," patient with the machinery of American democracy; accepting that, in time, they too will achieve their rights just as did the Irish, Italians, Jews, and others.

It is quite clear now that the violence that so "shocks" the white American springs from a well of bitterness, distrust, and potential (but increasingly real) hatred that is constantly fed by white complacency, indifference, and fear.

It is necessary here to point out that we are talking of attitudes, and attitudes on both sides are conceived of in terms of black and white. Few, on either side, would condemn or praise all individuals in either group.

The lesson that the white liberal has to learn is that, however outspoken and active he may be in his fight for "right," he is going to be thought of as "white" and so stigmatized to that extent. The white liberal who merely claims to think liberal, and does nothing about his comfortable thoughts, is classed by the bulk of Negroes with the worst of the whites. Even in many intimate relationships between whites and blacks the tentacles of the slave system are ever-present, motivating behavior, causing tensions. Black men kissing white women is a prime example, whereas white men kissing black women is more easily accepted. Black seniority in a predominantly white business is another cause of tension, as is the use of intimate forms of greeting (such as white children addressing elderly Negroes by first names). Sometimes this develops into a "joking relationship," where the tensions are temporarily released in mock name-calling.

Again, this does not mean that individual exceptions cannot exist. If they did not, and in good number, there would be no point in writing this article, for there would be no hope at all. We are not concerned, however, with individual relationships, nor should anyone make his own individual relationship, however successful, an excuse for claiming to be beyond the group relationship. We cannot escape our position in this wider society, however much we might resent it.

An article such as this cannot hope to do more than serve as a pointer; so, having made it clear that we are dealing with group behavior and group attitudes, we now propose to concentrate on one particular aspect of group behavior, namely violence. Further narrowing our scope, we do not propose to deal with white violence, except to point out that the initial violence—the violent act of enslavement and the incredibly vicious system of slavery that persisted in this country—came from the hands of the white man. This is not mentioned as a throwaway—it has relevance for our approach to Negro violence. Nor is assessment of the viciousness of the slavery system a gratuitous fling at the whites. It could be explained in cool, academic terms, but this should not be necessary since it is not implied that present-day whites can be held responsible for that system. The

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America

M. Turnbull

viciousness of American slavery, however, bears directly on our attempt to understand the source and nature of the present-day Negro violence. We should all ask ourselves a few simple questions. Who is being violent—a few hooligans (as most whites would like to believe), a certain segment of Negro society, or Negro society as a whole? Why are they being violent? What is the nature of the violence—calculating and deliberate, material, emotional, or what? What is the point, or purpose, of the violence? And above all, the ultimate anthropological question, what is the function of this violence? The last question will, when answered, give us a better understanding not only of the violent acts and their source but of the total problem.

Opportunistic hooliganism almost invariably accompanies any kind of social disturbance, and there is no doubt that it results directly in some individual acts of violence. But to claim that the total violent scene is caused by hooligans is to claim too much for them. Even if it were true that all those who pillaged and looted in recent riots were juvenile delinquents and hooligans—and this is demonstrably not true—we would still be left with the question of what produced such sudden unanimity of action. Many whites wonder why, as they put it, the violence usually seems to result in destruction of Negro life and property (in fact, most of the houses burned have been owned by whites). We are not aware of any statistics that could evaluate this, and they would be misleading in any case, for here we have to deal primarily with the issue of intent. The violence frequently is touched off in a Negro neighborhood. Whites put forward many comfortable reasons for this, such as overcrowding and unemployment: comfortable because they can be tackled in a forthright manner, and comfortable, above all, because they avoid the nagging possibility that the violence might stem from something a great deal more serious and basic—the white man himself and his myopia. The fact is that when violence starts, with arson and looting, in a Negro neighborhood, it is generally directed against stores owned by non-Negro storekeepers. These storekeepers are often suspected (with some justice and some injustice, but always with feeling) of overcharging and of monopolistic dealings that prevent Negroes from competing. The truth of the suspicion is, for the moment, irrelevant; the conviction among Negroes in urban areas that this is so is real and a truth of its own. It is this truth we have to deal with—the storekeepers are relatively trivial in importance.

We ask ourselves the question, what does the looter think he is doing when he loots a store? What is he trying to achieve? Is he really risking being shot dead by police in order to get an armful of cheap hosiery or, if he is lucky, a television set worth, at most, a few hundred dollars? What does the arsonist think he is doing when he sets fire to a store? Does he even consider the possibility that the fire might spread and burn down neighboring houses in which his own family may be living? We suggest that there is no explanation along these lines unless we take the position that the violence is mass hysteria. But there again, while there is an element of truth in the suggestion, we still have to find out the cause. It seems that viewing the violence—the arson, the looting, and the few incidents of killing by Negroes—as something symbolic is much more productive. It would require a great deal of research to investigate fully, but even a tentative essay suggests an understanding of the situation that would go far to explain the function of violence and the way to its eradication.

For instance, it is common in any time of crisis for mass hysteria to make itself felt in some way. But Negro violence is not always sparked by a crisis. Sometimes it seems self-generated, yet if there were a conspiracy it would have to involve considerable organization; and the very ineffectiveness of the violence, in evidently practical terms, is not suggestive of competent or even incompetent organization. If the violence is not triggered by a real crisis (such as that

which followed the assassination of Martin Luther King, Jr.), is not organized, and is not due to slum (politico-economic) conditions, we can only assume that it is a latent potential of the Negro community of such enormous power that it can barely be contained. Sporadic eruptions act as safety valves, and a decidedly uncomfortable thought is that even the worst eruption we have seen to date is no more than a tiny trickle of escaping steam. We are all, black and white alike, sitting on top of an unbelievable inferno.

Even so, it is helpful to consider these eruptions, for by studying them perhaps we can quench the underlying fire. They appear to be meaningless, stupid acts; but while they may be thoughtless, they are not stupid. The Negro youth who runs from a burning store holding a child's doll is clutching far more than fifteen dollars' worth of merchandise: he is clutching a symbol of all that he is deprived of in this anything but equal world. The arsonist who touches off a blaze that will engulf the homes of his fellows, and perhaps only bring a fat insurance payoff to the non-Negro storekeeper, is symbolically destroying the society that pens him in; he is purging himself with fire, for, in biblical thought, the symbolic fire consumes only the evil and leaves the righteous untouched. Discussion with arsonists and looters would seem to bear this out. The violence is a symbol of the consuming bitterness felt by the Negro in his deprivation. Again let us hasten to say that whether or not he is deprived is altogether a side issue. What is important is whether or not he *believes* he is deprived, and there can be no mistake about that.

Violence is also a symbol of defiance, and when we consider this aspect, or its possibility, we begin to approach the issue of function. It is primarily youths who instigate the violence, but this in no way suggests that the feelings of defiance, frustration, and bitterness are confined to them. Although older Negroes might well criticize the violence, as might the non-violent section of the community, it is likely that these feelings are widespread, and are merely manifested in different ways. The emotions of some pacifists, for instance, are in their way as violent as the deeds of rioters and the words of militants. The non-violent campaign of Marti[n] Luther King sprang from the sam[e] well of bitterness as the violence o[f] those it condemned. The only divi[-] sion of opinion here is concerne[d] with method. Whites should not thin[k] that bitterness is confined to a few[.] As yet, fortunately, hatred *is* so con[-] fined.

Any such latent emotion is obvi[-] ously disruptive to society, but it i[s] by no means uncommon. Here it i[s] instructive to look at African societ[y] where it is frequently recognized tha[t] there is a great potential for violenc[e] between rulers and ruled. This is als[o] true between neighboring peoples[.] The violence, in a sense, is inheren[t] in the situation, for wherever there i[s] a ruler, there is the possibility, if h[e] is human, of misrule. Wherever ther[e] are neighbors, there is the possibilit[y] of envy. A common solution in Afric[a] is to accept the unhappy fact and dea[l] with it by formalizing it in ritual act[s] of rebellion. Thus, on certain stat[e] occasions, subjects may be expected[,] even demanded, to revile their kin[g] or to threaten him with spears, re[-] minding him of the instability of hi[s] own position. Neighboring tribes, i[n] precolonial days, formalized the eve[r] present danger of warfare by the in[-] stitution of raids. Each side occasion[-] ally made a foray against the other[,] thereby asserting its own superiority[.] It was a game, so to speak, in whic[h] everyone won, except for the few in[-] dividuals who were killed (ofte[n] even those individuals won, for i[n] their thought future life was some[-] times considered of greater impo[r-] tance than present life). It was [a] common mistake of administrators t[o] attribute the most obvious caus[e,] usually economic, to such raids, or t[o] believe that ritual acts of rebellio[n] betokened the imminence of real re[-] bellion. We may be in the sam[e] danger here: by treating sporad[ic] violence as an actual rebellion an[d] by stamping it out with more vi[o-] lence, we merely increase the poten[-] tiality of a real rebellion.

It is impossible to say, at presen[t,] to what extent the summer violence o[f] past years has been an end in itse[lf] —an act of violence arising direct[ly] from socioeconomic conditions—an[d] to what extent it has been symbol[ic] of a more deep-seated cause. The[re] are bound to be elements of both, f[or] the socioeconomic deprivation of th[e] Negro is real enough. The nature

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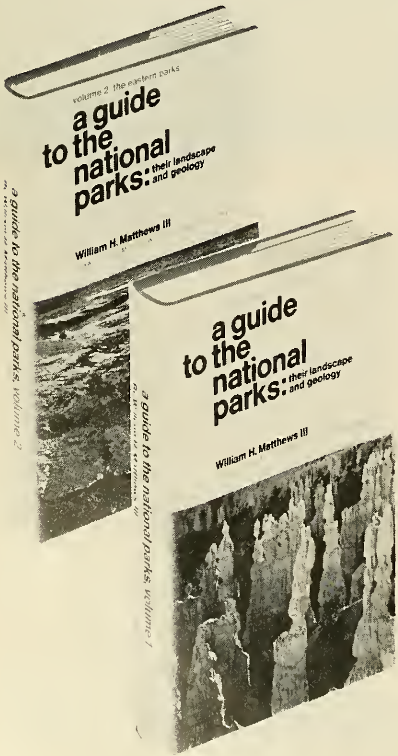

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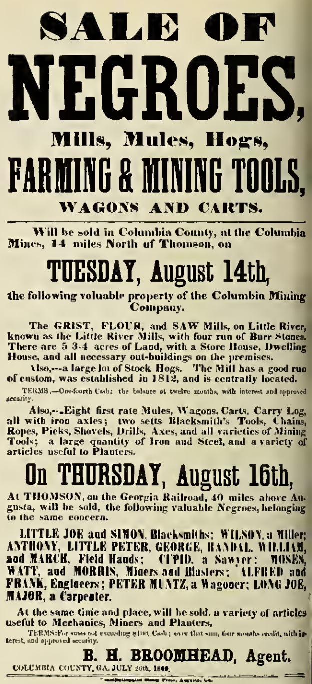
the violence, however, indicates that there is much more to it. Its apparent aimlessness; the futility in terms of gain; the good humor that often accompanies it, making it, briefly, a rather jolly social occasion; and its unpredictability are all symptoms of a more deeply rooted malaise than poverty. Again we are tempted to think of African crisis rituals where destruction of property is mandatory and is usually carried out dutifully by a definite age-set, commonly youths. The destruction is not by any means always aimed at known offenders, although they will usually be included. It is as though the crisis that has befallen the society (death, an epidemic, drought, etc.) is due to the total failure of the society as such to behave in what is considered a correct manner. Everyone is guilty, and the violence is therefore indiscriminate. Houses are torn down, property destroyed, people beaten, animals slaughtered. This is not primitive, barbaric savagery: it is a very sensible and necessary catharsis. It purges society, which then returns to the lawful way—at least for a time. Negro American violence, then, might be taken as a comment on the total failure of our total society. The destruction is not necessarily aimed at specific offenders, but is rather a symbol of the despair that there can be any goodness or justice anywhere. The violence purges the Negro American, and perhaps it also temporaril purges a few whites who may becom involved in one way or another. Th fact that it does not improve relation is neither here nor there. Hostility i a perfectly equable social relatio ship and, if openly recognized, is fr quently much more conducive t social stability than an uneasi founded amity. So in terms of tl stability of our society we should n be too upset that we do not all lo each other. It is more important th we find out just what our feelin really are.

Here again violence serves a us ful function, at least temporarily, u til a better solution can be found. enforces a confrontation of the c posed parties. If it were not for t outbreaks of violence, white liber and black liberals alike would go thinking that all was being solved progressive legislation, a little t fast for some and too slow for othe but all that was needed. But rac

animosity is too ingrained to be uprooted by legislation. The violence exhibited so far is a mere token of the potential held by the Negro population of this country. The wonder is that there has been so little. We suggest that the violence has been limited because, until now, it has been symbolic, almost ritualistic, requiring that troops be called out to turn our cities into what appear to be cities of a country torn by civil war. There is a symbolic defiance of a law that is considered ineffectual and unjust. There is a reversal of roles (another frequent crisis-institution in African society) in that it is the Negro who now initiates the violence, in contrast to the original act of white violence. It is also a reversal of the superordinate and subordinate, of the active and passive. We think that among the younger generation of Negro Americans there is a much greater awareness and resentment of the passive, submissive role played by their parents. We might question the depth of that submission, for frequently it was a guise assumed to make the best of a physically unalterable situation, and one that enabled the Negro to retain what otherwise would surely have been totally destroyed—his sense of identity and pride. The slavery system was such that the manhood of the Negro was all but taken away from him. While we will not go into that here, the fact that slaves were owned and sold as farm livestock (boys were sold by the inch), were advertised as such, and were used for breeding should be enough to indicate the kind of battle the Negro must have had to retain his identity as a human being. We know of more subtle, modern methods of brainwashing prisoners into total acceptance, but it is questionable if they are more effective. The result was, to varying degrees of course, submission. Frequently the Negro kept some identity and pride by living a double life; he assumed the image his master had of him when in front of his master and kept his real self hidden, barely letting it emerge even in his own home. But the Negro of the new generation is finally, it seems, removed from the slave complex. He is no longer interested in whether it was his grandfather or great-great-grandfather who was a slave. He is ashamed of the submission he sees among older Negroes, not understanding that it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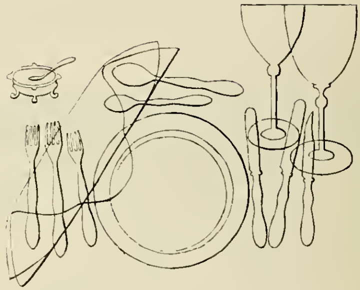
is, in itself, a defense mechanism, and he is not prepared to be submissive himself. In this sense the revolt is real, not symbolic. It is a revolt against his own submissiveness, a violent assertion of his manhood. But then we should not think that the violence is anything but a minute token of what is to come, unless, in some miraculous way, the Negro is accorded true equality as he conceives it.

Again it must be stressed that this equality is not merely one of economic opportunity; nor does the Negro particularly care any longer wha[t] the white thinks of him. If we accep[t] that the violence is symbolic of a[n] assertion of masculinity, then wha[t] the Negro wants is to be accepted as [a] man; not necessarily good or necessarily bad but, as a man, equal.

If we treat these outbreaks of violence merely as lawless acts and tr[y] to suppress them as such, we mis[s] the whole import of the situation, an[d] far more dangerously, we block [a] vital safety valve. It would seem un[-] reasonable to advocate that violenc[e] should be countenanced, and that i[s] not our intention, but it should b[e] understood. If we treat it as me[re] lawlessness, or if we try to check it b[y]

offering material inducements such as better housing, we fool ourselves and nobody else. The plea for all men to love each other regardless of color, however laudable, also will not answer the demand for respect of Negro manhood, for love can be unbearably paternalistic, serving only to reinforce the superordinate/subordinate relationship that is at the root of the problem. If, rather more realistically, we recognize that all men are not going to love each other, for a while at least, and we try to replace one set of opposite relationships with another, more congenial to the Negro, we are likely to be on the right track toward a more peaceful and stable society. At present the opposition between white and black is one of hostility, in which lies the potential of violence, so far averted by sporadic outbreaks of what has only been token violence. Perhaps what is needed is less feeling that, in a rather cozy way, we should pour material wealth and opportunity from the white side of the scales onto the black side—and mix the colors while we are about it—but more a recognition that every man has his own identity and is entitled to keep it, and so has every social group. Perhaps we need a new outlet for the bitterness of which violence is a manifestation. The Africanization of the young Negro American is such an outlet, through which he can, with pride, assert his identity in non-violent opposition to the white. Yet, paradoxically, the more pride the Negro finds in himself, and the greater his economic and political advancement, the greater the danger. For, either he sinks, self-satisfied, into a "black bourgeoisie," articulating the same values as the whites, concerned only with his new-found security: or more likely, seeing the final goal in sight, he redoubles his efforts and his militancy, leading to further violence.

Given the opportunity to assert all the privileges of citizenship, which are still in part denied him, the potential for violence will be lessened, but there is evidence that even now the conservative "black bourgeois" is losing his self-complacency, adding his weight to that of the militants. There is a very long way to go before the well of bitterness is drained, however, and until this is done, violence is likely to remain a threat that is, at the same time, an uneasy safety valve against a much greater disaster.



Vive la Différence

by Marston Bates

Some people eat with a knife and fork, others with chopsticks, and still others use their fingers. Among the knife-and-fork people, the British think Americans are funny because of the way they keep shifting the fork from the left to the right hand; Americans, on the other hand, may be fascinated by the British skill in stashing peas in the mashed potatoes on the back of the fork—held always in the left hand. To each of us, of course, our way of doing things is the right way. This would not matter much if it were not for the complications of the "missionary syndrome," which leads us to try to persuade other people to adandon their ways and take up ours.

The etiquette of eating is trivial: except maybe at diplomatic dinners, where I suppose that an ambassador might seriously compromise the international standing of his country by picking up the wrong fork. But our attitudes toward food—kinds and ways of eating it—illustrate an intolerance that has deeper and far more serious aspects. This is what led me in my last book, *Gluttons and Libertines,* to start with the idea of ridiculing our attitudes toward sex by finding parallels in the less highly charged attitudes toward food. I soon found myself going beyond food and sex and writing a sort of general plea for the tolerance of diversity. Nicholas Samstag, in an amusing notice in *The Saturday Review,* said the title of the book should have been "*Vive la Différence,* or The Spice of Variety."

I still like my own title, although I must admit that Samstag's suggestion is a better indication of the book's actual contents. As time goes on, I become more and more impressed with the positive value of diversity—with the urgent need for learning tolerance—and I cannot resist the temptation to sound off on the subject once more.

There are, of course, many kind of diversity. In the world of nature we have the possibility of diversity in the gene pool of a given specie of organism; diversity in kinds o plants and animals in a biologica community; diversity in kinds o communities, from desert to rain for est or from ocean depths to cora reef.

Diversity in the gene pool of species provides the raw material fo evolution, makes possible adaptatio to changing environments, and a lows for flexibility. Diversity in th biological community, on the othe hand, makes for stability and co tinuity. This can be seen in the co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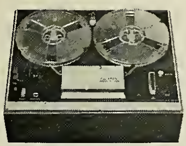

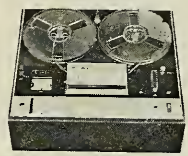

trast between the relatively simple communities of the far north and the complex aggregations of animals and plants that make up a tropical rain forest or a coral reef. The animal populations in the far north fluctuate greatly, though more or less regularly, from year to year, as is shown by the fur records of the Hudson's Bay Company over a period of a hundred years. In the case of showshoe hares and lynx, an increase in the number of hares is followed by an increase in the predatory lynx, until the hare population is again reduced to scarcity, leading, in turn, to a decline in the numbers of lynx. This results in a fairly regular series of cyclic fluctuations at about ten-year intervals. Such cyclic fluctuations are unknown in the rain forest, where the complexity of prey–predator relations makes for flexibility and results in a relatively steady state for all populations. But the various arguments for maintaining diversity in biological systems are well summarized by that great British ecologist Charles Elton in a chapter on "The Conservation of Variety" in *The Ecology of Invasions*, published in 1958.

The diversity in biological communities has enabled life to take advantage of almost all the varied conditions on our planetary surface—the chief exceptions being ice caps and extreme deserts. What variety there is! Somehow we must keep these varied landscapes from being entirely swamped by human alterations so that future generations can. in some degree, share experience with the wilderness.

There is need for diversity among people, too, whether looked at as individuals, as communities, or as large societies. We try to recognize the need of the individual in our educational system. attempting to give everyone, whatever his future specialty, some background in the arts, the sciences, and the humanities: some experience with differing points of view. That we do not succeed very well is no reflection on the soundness of the idea. In another way, the concept of "vacation" expresses our felt need for refreshing change. The cult of hobbies is, again, a manifestation of diversity in the activities of individuals, and as work becomes more monotonous and more specialized, the need to escape with a vacation or a hobby becomes greater.

Beyond this, there is the matter of role diversity within a society—and culture diversity among societies. Contemporary Western civilization must have a greater variety of possible roles than any previous culture, a consequence of our increasing specialization. Yet there is still a great and valid outcry against the pressures for conformity. I think this is because we have many possible occupations, but few permissible styles of life. The monotony shows in the rows of little boxes in the suburbs, in the standardized education, in the multiplying chain stores and shopping centers, in the routine of the assembly line. And monotony, meaninglessness, and frustration are compounded in our ghettos.

The West, in the last few hundred years, has had a bulldozing effect on other cultures. Our power to enforce our ideas is declining, but it still has considerable momentum. I remember reading somewhere that Indonesia, influenced by Western ideas of modesty, has required the dancing girls of Bali to cover their breasts. The Japanese are said to be somewhat worried about Western attitudes toward their abortion laws. And to me it seems particularly odd to see Japanese, Malays, Hindus, and Nigerians dressed up in our silly Western clothing. There is a growing movement to retain indigenous dress, but it is still not quite respectable in diplomatic circles. I sometimes suspect that the chief trouble with Fidel Castro is his beard and windbreaker. It probably ought to be his interminable speeches—but you can hardly carry out diplomatic negotiations with a man wearing a windbreaker.

The opposite of diversity is uniformity. An interesting word—uniform. Standardized dress serves to depersonalize the soldier, the policeman, the waiter, or bellboy. The effect is to convert individuals into abstractions. symbols of some occupation or hierarchical rank, drab units in a "brave new world."

In this connection I find the nonconforming antics of our young fascinating, and there is plenty of chance for observation in a university environment. They are obviously rebelling against the adult world that they are entering—I can't blame them when I look at the mess we have made of things—and they flaunt th


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inner rebellion with an outer show of diversity in dress. It at least succeeds in upsetting the police, the school authorities, and, probably, the parents; a reaction that I fail to understand except in terms of our unease about anything different. The "beats" of a few years ago seemed pretty uniform—conforming to the standards of the group, however different these might be from the standards of the larger society. But I see no such uniformity in the youth of today. The only uniformity is the effort to be different, to be individual.

The boys may have long hair or short, sideburns, beards, moustaches, or goatees; they may go barefooted, wear boots, or (perhaps most commonly) dirty sneakers. Their trousers may be tight or loose, levis or corduroys, or shorts made by attacking trousers with a pair of scissors. They may wear an earring and/or a variety of kinds of ornaments hung around the neck. They sometimes manage to look quite dirty, although I suspect most of them bathe often enough; they haven't gone back to the Saturday-night sponging of our ancestors. What is all the fuss about?

Some of the boys, with their neatly trimmed and combed long hair, look as though they might have stepped out of some castle in the Middle Ages; more, I am afraid, look like seventeenth-century pirates, and their beards are often reminiscent of the fashions of the last century, as are some of the "mod" clothes.

A large proportion of the girls have taken to wearing masculine clothing. This is understandable in practical terms—at least they get pockets. I sometimes wonder, though, at the amount of trouble they must take to look so disheveled; the effect seems contrived rather than accidental.

The consequence of these boy-gir[l] tendencies in dress is to minimiz[e] the differences between the sexes which our traditional clothing exaggerates. I am reminded of Geoffre[y] Gorer's observation that non-aggressive human societies "make ver[y] little distinction between the idea[l] characters of men and women, par[-]ticularly that they have no ideal o[f] brave, aggressive masculinity." [I] really think our young are non-aggressive, although they can be ob[-]stinate enough. The fierce posturing[s] are made by people of my gener[ation]

he Winstons aren't trying to save the world. st a little piece of it.

here are Apaches on the reser-n in Clear Fork, Arizona, who remember the last, hopeless he uprising in 1900. But for a Alakay, a seven-year-old he, the enemy is not the U.S. lry.

he and her people are fighting ner kind of war. This time the nies are poverty, disease and air. And for the first time in gen-ons, there's a chance that the hes might win: thanks to the ageous efforts of her own people other Americans like the tons.

nne and Stan Winston and two daughters live in a New suburb 2,000 miles from the vation. But it's another world. Winstons live in a big, old house omplain about a big, new mort-. Their girls have a closetful of es and "nothing to wear." They bikes, skates, games, books, rec-and "nothing to do."

Della and her seven brothers sisters have none of these prob-. Her father spends as much time looking for work as he does working. Sanitary facilities are almost non-existent. Electricity has yet to reach them. Water is hauled by hand. Even the

st necessities are hard to come by.

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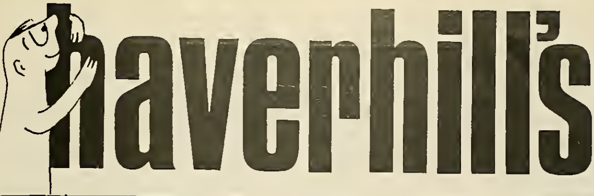
tion, in no immediate danger of landing on the firing line.

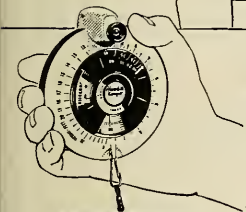
How do we distinguish right from wrong in the puzzling, relative world in which we live? I like the answer given by Philip Wylie—perhaps best known for *Generation of Vipers*—in a recently published book entitled *The Magic Animal.* It is a shrill, almost paranoid book, which sometimes sounds as though only the author clearly understood what a mess we are making of things. The standard of ethics, the "biological imperative," that he proposes would be to judge actions in terms of the needs of posterity. Not in terms of our own family, or of future Americans or Japanese, but in terms of "all the children of mankind." "To evaluate a culture properly," he writes, "one must balance its gains and deficits in relation to the future generations of all human beings."

This would leave most of our daily behavior ethically neutral, whether concerned with work or play, food or sex (unless unduly contributing to the population problem); but it would condemn our wanton exploitation of resources, our damage to the environment of this "spaceship earth" in which those future generations will have to live. What has this got to do with diversity? It leaves a wide range of tolerance for individual and cultural behavior that is not destructive, and it implies a command to maintain the diversity of the biosphere so that our children, too, can enjoy clear trout streams, giant redwoods, deep canyons, and open spaces.

I think there is a corollary: that we should tolerate diversity in behavior to the extent that it does not damage the continuity of society. Antisocial activities should be classified as "crimes." But who is to decide what is antisocial, and how can it be decided? Murder, genocide, and war seem to me clearly evil; but all can be, and have been, justified in terms of the "good" of continuing society. And I am sure there are people in our country who regard boys wearing earrings as a sign of the collapse of all our treasured values, a mark of social disintegration.

The answer probably lies in "common sense." But whose, yours or mine? We can't all think alike—that would be uniformity instead of diversity. So let's argue—but let's not kill each other in the process.





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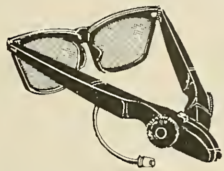

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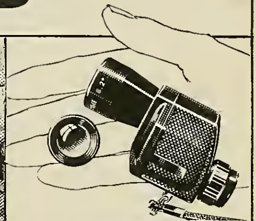

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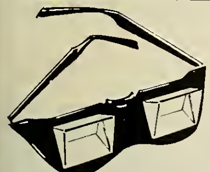

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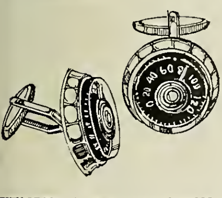

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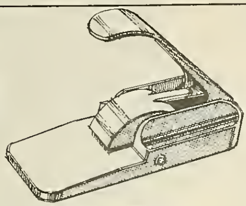

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The Sound of Rushing Water

A hallucinogenic drug gives the Jívaro shaman entrance to the "real" world and gives him the power to cure or bewitch

by Michael J. Harner

He had drunk, and now he softly sang. Gradually, faint lines and forms began to appear in the darkness, and the shrill music of the *tsentsak*, the spirit helpers, arose around him. The power of the drink fed them. He called, and they came. First, *pangi*, the anaconda, coiled about his head, transmuted into a crown of gold. Then *wampang*, the giant butterfly, hovered above his shoulder and sang to him with its wings. Snakes, spiders, birds, and bats danced in the air above him. On his arms appeared a thousand eyes as his demon helpers emerged to search the night for enemies.

The sound of rushing water filled his ears, and listening to its roar, he knew he possessed the power of *tsungi*, the first shaman. Now he could see. Now he could find the truth. He stared at the stomach of the sick man. Slowly, it became transparent like a shallow mountain stream, and he saw within it, coiling and uncoiling, *makanchi*, the poisonous serpent, who had been sent by the enemy shaman. The real cause of the illness had been found.

The Jívaro Indians of the Ecuadorian Amazon believe that witchcraft is the cause of the vast majority of illnesses and non-violent deaths. The normal waking life, for the Jivaro, is simply "a lie," or illusion, while the true forces that determine daily events are supernatural and can only be seen and manipulated with the aid of hallucinogenic drugs. A reality view of this kind creates a particularly strong demand for specialists who can cross over into the supernatural world at will to deal with the forces that influence and even determine the events of the waking life.

These specialists, called "shamans" by anthropologists, are recognized by the Jívaro as being of two types: bewitching shamans or curing shamans. Both kinds take a hallucinogenic drink, whose Jívaro name is *natema*, in order to enter the supernatural world. This brew, commonly called *yagé*, or *yajé*, in Colombia, *ayahuasca* (Inca "vine of the dead") in Ecuador and Peru, and *caapi* in Brazil, is prepared from segments of a species of the vine *Banisteriopsis*, a genus belonging to the Malpighiaceae. The Jívaro boil it with the leaves of a similar vine, which probably is also a species of *Banisteriopsis*, to produce a tea that contains the powerful hallucinogenic alkaloids harmaline, harmine, d-tetrahydroharmine, and quite possibly dimethyltryptamine (DMT). These compounds have chemical structures and effects similar, but not identical, to LS[D], mescaline of the peyote cactus, and psilocybin of t[he] psychotropic Mexican mushroom.

When I first undertook research among the Jívaro [in] 1956-57, I did not fully appreciate the psychologic[al] impact of the *Banisteriopsis* drink upon the native vie[w] of reality, but in 1961 I had occasion to drink the h[al]lucinogen in the course of field work with another Upp[er] Amazon Basin tribe. For several hours after drinki[ng] the brew, I found myself, although awake, in a wor[ld] literally beyond my wildest dreams. I met bird-head[ed]

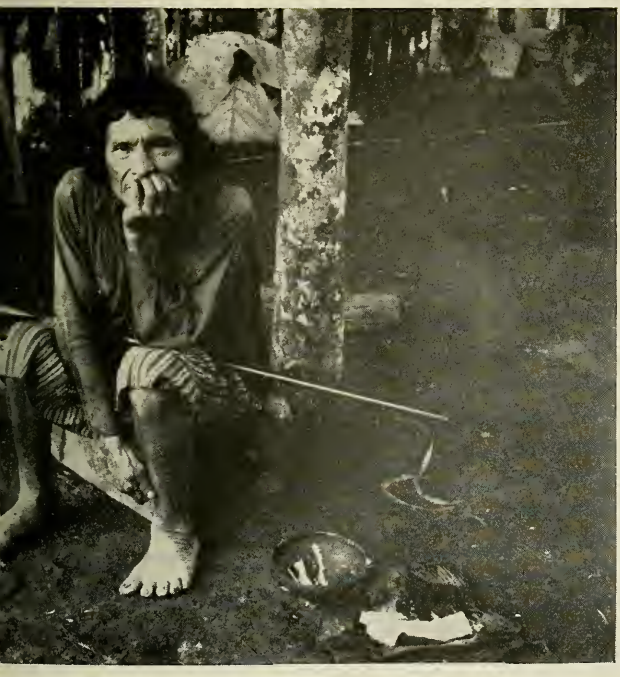
·ople, as well as dragon-like creatures who explained at they were the true gods of this world. I enlisted e services of other spirit helpers in attempting to fly rough the far reaches of the Galaxy. Transported into trance where the supernatural seemed natural, I real-ed that anthropologists, including myself, had pro-undly underestimated the importance of the drug in fecting native ideology. Therefore, in 1964 I returned the Jívaro to give particular attention to the drug's e by the Jívaro shaman.

The use of the hallucinogenic *natema* drink among e Jívaro makes it possible for almost anyone to achieve e trance state essential for the practice of shamanism. iven the presence of the drug and the felt need to con-ct the "real," or supernatural, world, it is not surpris-g that approximately one out of every four Jívaro en is a shaman. Any adult, male or female, who de-es to become such a practitioner, simply presents a ft to an already practicing shaman, who administers e *Banisteriopsis* drink and gives some of his own su-rnatural power—in the form of spirit helpers, or *entsak*—to the apprentice. These spirit helpers, or larts," are the main supernatural forces believed to use illness and death in daily life. To the non-shaman ey are normally invisible, and even shamans can per-ive them only under the influence of *natema*.

Shamans send these spirit helpers into the victims' bodies to make them ill or to kill them. At other times, they may suck spirits sent by enemy shamans from the bodies of tribesmen suffering from witchcraft-induced illness. The spirit helpers also form shields that protect their shaman masters from attacks. The following account presents the ideology of Jívaro witchcraft from the point of view of the Indians themselves.

To give the novice some *tsentsak*, the practicing shaman regurgitates what appears to be—to those who have taken *natema*—a brilliant substance in which the spirit helpers are contained. He cuts part of it off with a machete and gives it to the novice to swallow. The recipient experiences pain upon taking it into his stomach and stays on his bed for ten days, repeatedly drinking *natema*. The Jívaro believe they can keep magical darts in their stomachs indefinitely and regurgitate them at will. The shaman donating the *tsentsak* periodically blows and rubs all over the body of the novice, apparently to increase the power of the transfer.

The novice must remain inactive and not engage in sexual intercourse for at least three months. If he fails in self-discipline, as some do, he will not become a successful shaman. At the end of the first month, a *tsentsak* emerges from his mouth. With this magical dart at his disposal, the new shaman experiences a tremendous



Washikta, an outstanding Jívaro shaman, quietly listens to a visitor's request for assistance. As is customary when dealing with strangers, he keeps a shotgun in readiness during the consultation.

desire to bewitch. If he casts his *tsentsak* to fulfill this desire, he will become a bewitching shaman. If, on the other hand, the novice can control his impulse and reswallow this first *tsentsak*, he will become a curing shaman.

If the shaman who gave the *tsentsak* to the new man was primarily a bewitcher, rather than a curer, the greater the variety of these objects that a shaman has in his body, the greater is his ability.

According to Jívaro concepts, each *tsentsak* has a natural and supernatural aspect. The magical dart's natural aspect is that of an ordinary material object as seen without drinking the drug *natema*. But the supernatural and "true" aspect of the *tsentsak* is revealed to

The drawings shown here depict figures seen by the shaman Mashu, while under the influence of the powerful Banisteriopsis *drink,* natema. *At left is the head of a jaguar that appeared in one of Mashu's visions. The shaman, who had never drawn before, used pencil and paper supplied by the author.*

novice likewise will tend to become a bewitcher. This is because a bewitcher's magical darts have such a desire to kill that their new owner will be strongly inclined to adopt their attitude. One informant said that the urge to kill felt by bewitching shamans came to them with a strength and frequency similar to that of hunger.

Only if the novice shaman is able to abstain from sexual intercourse for five months, will he have the power to kill a man (if he is a bewitcher) or cure a victim (if he is a curer). A full year's abstinence is considered necessary to become a really effective bewitcher or curer.

During the period of sexual abstinence, the new shaman collects all kinds of insects, plants, and other objects, which he now has the power to convert into *tsentsak*. Almost any object, including living insects and worms, can become a *tsentsak* if it is small enough to be swallowed by a shaman. Different types of *tsentsak* are used to cause different kinds and degrees of illness. The

the shaman by taking *natema*. When he does this, th magical darts appear in new forms as demons and wit new names. In their supernatural aspects, the *tsentsa* are not simply objects but spirit helpers in variou forms, such as giant butterflies, jaguars, or monkeys who actively assist the shaman in his tasks.

Bewitching is carried out against a specific, know individual and thus is almost always done to neighbor or, at the most, fellow tribesmen. Normally, as is th case with intratribal assassination, bewitching is don to avenge a particular offense committed against one' family or friends. Both bewitching and individual assas sination contrast with the large-scale headhunting raid for which the Jívaro have become famous, and whic were conducted against entire neighborhoods of enem tribes.

To bewitch, the shaman takes *natema* and secretly ap proaches the house of his victim. Just out of sight in th forest, he drinks green tobacco juice, enabling him t

regurgitate a *tsentsak*, which he throws at his victim as he comes out of his house. If the *tsentsak* is strong enough and is thrown with sufficient force, it will pass all the way through the victim's body causing death within a period of a few days to several weeks. More often, however, the magical dart simply lodges in the victim's body. If the shaman, in his hiding place, fails to see the intended victim, he may instead bewitch any member of the intended victim's family who appears, usually a wife or child. When the shaman's mission is accomplished, he returns secretly to his own home.

One of the distinguishing characteristics of the bewitching process among the Jívaro is that, as far as I could learn, the victim is given no specific indication that someone is bewitching him. The bewitcher does not want his victim to be aware that he is being supernaturally attacked, lest he take protective measures by immediately procuring the services of a curing shaman. Nonetheless, shamans and laymen alike with whom I talked noted that illness invariably follows the bewitchment, although the degree of the illness can vary considerably.

A special kind of spirit helper, called a *pasuk*, can aid the bewitching shaman by remaining near the victim in the guise of an insect or animal of the forest after the bewitcher has left. This spirit helper has his own objects to shoot into the victim should a curing shaman succeed in sucking out the *tsentsak* sent earlier by the bewitcher who is the owner of the *pasuk*.

In addition, the bewitcher can enlist the aid of a *wakani* ("soul," or "spirit") bird. Shamans have the power to call these birds and use them as spirit helpers in bewitching victims. The shaman blows on the *wakani* birds and then sends them to the house of the victim to fly around and around the man, frightening him. This is believed to cause fever and insanity, with death resulting shortly thereafter.

After he returns home from bewitching, the shaman may send a *wakani* bird to perch near the house of the victim. Then if a curing shaman sucks out the intruding object, the bewitching shaman sends the *wakani* bird more *tsentsak* to throw from its beak into the victim. By continually resupplying the *wakani* bird with new *tsentsak*, the sorcerer makes it impossible for the curer to rid his patient permanently of the magical darts.

While the *wakani* birds are supernatural servants available to anyone who wishes to use them, the *pasuk*, chief among the spirit helpers, serves only a single shaman. Likewise a shaman possesses only one *pasuk*. The *pasuk*, being specialized for the service of bewitching, has a protective shield to guard it from counterattack by the curing shaman. The curing shaman, under the influence of *natema*, sees the *pasuk* of the bewitcher in human form and size, but "covered with iron except for its eyes." The curing shaman can kill this *pasuk* only by shooting a *tsentsak* into its eyes, the sole vulnerable area in the *pasuk*'s armor. To the person who has not taken the hallucinogenic drink, the *pasuk* usually appears to be simply a tarantula.

Shamans also may kill or injure a person by using magical darts, *anamuk*, to create supernatural animals that attack a victim. If a shaman has a small, pointed

Many times the Christian missionary had told Mashu of the devil feared by white men. But since he had never seen the spirit, Mashu remained skeptical. Some time later, after drinking natema, *Mashu was confronted by this figure of the "white man's devil." Since that time, Mashu has remained convinced of this spirit's reality.*

Whenever the shaman is curing or bewitching, his head remains covered by this halo-like crown. The crown can be seen by those drinking natema, *but remains hidden from other onlookers.*

armadillo bone *tsentsak*, he can shoot this into a river while the victim is crossing it on a balsa raft or in a canoe. Under the water, this bone manifests itself in its supernatural aspect as an anaconda, which rises up and overturns the craft, causing the victim to drown. The shaman can similarly use a tooth from a killed snake as a *tsentsak*, creating a poisonous serpent to bite his victim. In more or less the same manner, shamans can create jaguars and pumas to kill their victims.

About five years after receiving his *tsentsak*, a bewitching shaman undergoes a test to see if he still retains enough *tsentsak* power to continue to kill successfully. This test involves bewitching a tree. The shaman, under the influence of *natema*, attempts to throw a *tsentsak* through the tree at the point where its two main branches join. If his strength and aim are adequate, the tree appears to split the moment the *tsentsak* is sent into it. The splitting, however, is invisible to an observer who is not under the influence of the hallucinogen. If the shaman fails, he knows that he is incapable of killing a human victim. This means that, as soon as possible, he must go to a strong shaman and purchase a new supply of *tsentsak*. Until he has the goods with which to pay for this new supply, he is in constant danger, in his proved weakened condition, of being seriously bewitched by other shamans. Therefore, each day, he drinks large quantities of *natema*, tobacco juice, and the extract of yet another drug, *piripiri*. He also rests on his bed at home to conserve his strength, but tries to conceal his weakened condition from his enemies. When he purchases a new supply of *tsentsak*, he can safely cut down on his consumption of these other substances.

The degree of illness produced in a witchcraft victim is a function of both the force with which the *tsentsak* is shot into the body, and also of the character of th magical dart itself. If a *tsentsak* is shot all the wa through the body of a victim, then "there is nothing fo a curing shaman to suck out," and the patient dies. I the magical dart lodges within the body, however, it i theoretically possible to cure the victim by sucking. Bu in actual practice, the sucking is not always considere successful.

The work of the curing shaman is complementary t that of a bewitcher. When a curing shaman is called i to treat a patient, his first task is to see if the illness i due to witchcraft. The usual diagnosis and treatmen begin with the curing shaman drinking *natema*, tobacc juice, and *piripiri* in the late afternoon and early eve ning. These drugs permit him to see into the body of th patient as though it were glass. If the illness is due t sorcery, the curing shaman will see the intruding objec within the patient's body clearly enough to determin whether or not he can cure the sickness.

A shaman sucks magical darts from a patient's bod only at night, and in a dark area of the house, for it i only in the dark that he can perceive the drug-induce visions that are the supernatural reality. With the se ting of the sun, he alerts his *tsentsak* by whistling th tune of the curing song; after about a quarter of a hour, he starts singing. When he is ready to suck, th shaman regurgitates two *tsentsak* into the sides of hi throat and mouth. These must be identical to the on he has seen in the patient's body. He holds one of thes in the front of the mouth and the other in the rear. The are expected to catch the supernatural aspect of th magical dart that the shaman sucks out of the patient body. The *tsentsak* nearest the shaman's lips is suppose to incorporate the sucked-out *tsentsak* essence withi itself. If, however, this supernatural essence should ge

past it, the second magical dart in the mouth blocks the throat so that the intruder cannot enter the interior of the shaman's body. If the curer's two *tsentsak* were to fail to catch the supernatural essence of the *tsentsak*, it would pass down into the shaman's stomach and kill him. Trapped thus within the mouth, this essence is shortly caught by, and incorporated into, the material substance of one of the curing shaman's *tsentsak*. He then "vomits" out this object and displays it to the patient and his family saying, "Now I have sucked it out. Here it is."

The non-shamans think that the material object itself is what has been sucked out, and the shaman does not disillusion them. At the same time, he is not lying, because he knows that the only important thing about a *tsentsak* is its supernatural aspect, or essence, which he sincerely believes he has removed from the patient's body. To explain to the layman that he already had these objects in his mouth would serve no fruitful purpose and would prevent him from displaying such an object as proof that he had effected the cure. Without incontrovertible evidence, he would not be able to convince the patient and his family that he had effected the cure and must be paid.

The ability of the shaman to suck depends largely upon the quantity and strength of his own *tsentsak*, of which he may have hundreds. His magical darts assume their supernatural aspect as spirit helpers when he is under the influence of *natema*, and he sees them as a variety of zoomorphic forms hovering over him, perching on his shoulders, and sticking out of his skin. He sees them helping to suck the patient's body. He must drink tobacco juice every few hours to "keep them fed" so that they will not leave him.

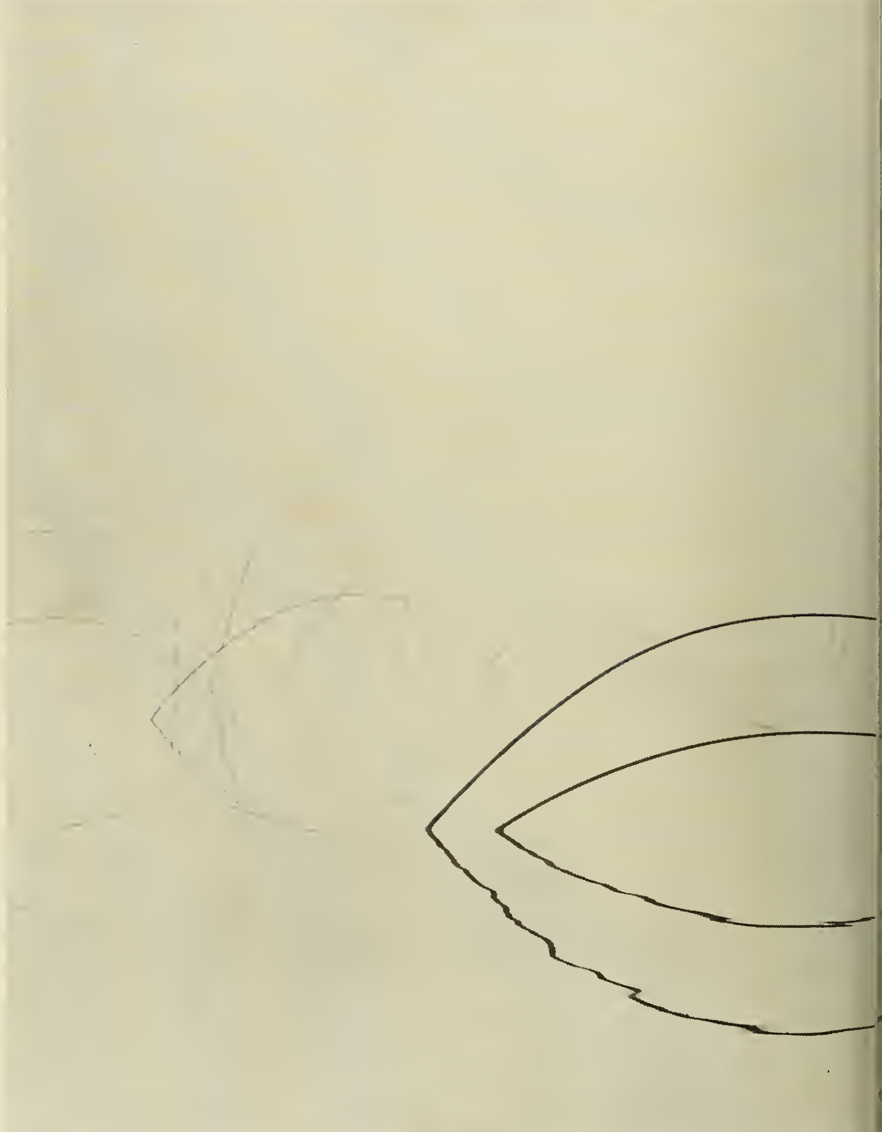
The curing shaman must also deal with any *pasuk* that may be in the patient's vicinity for the purpose of casting more darts. He drinks additional amounts of *natema* in order to see them and engages in *tsentsak* duels with them if they are present. While the *pasuk* is enclosed in iron armor, the shaman himself has his own armor composed of his many *tsentsak*. As long as he is under the influence of *natema*, these magical darts cover his body as a protective shield, and are on the lookout for any enemy *tsentsak* headed toward their master. When these *tsentsak* see such a missile coming, they immediately close up together at the point where the enemy dart is attempting to penetrate, and thereby repel it.

If the curer finds *tsentsak* entering the body of his patient after he has killed *pasuk*, he suspects the presence of a *wakani* bird. The shaman drinks *maikua* (*Datura* sp.), an hallucinogen even more powerful than *natema*, as well as tobacco juice, and silently sneaks into the forest to hunt and kill the bird with *tsentsak*. When he succeeds, the curer returns to the patient's home, blows all over the house to get rid of the "atmosphere" created by the numerous *tsentsak* sent by the bird, and completes his sucking of the patient. Even after all the *tsentsak* are extracted, the shaman may remain another night at the house to suck out any "dirtiness" (*pahuri*) still inside. In the cures which I have witnessed, this sucking is a most noisy process, accompanied by deep, but dry, vomiting.

After sucking out a *tsentsak*, the shaman puts it into a little container. He does not swallow it because it is not his own magical dart and would therefore kill him. Later, he throws the *tsentsak* into the air, and it flies back to the shaman who sent it originally into the patient. *Tsentsak* also fly back to *(Continued on page 60)*

This snake tsentsak *was seen by Mashu, coiled within the stomach of one of his patients. To work his cure, Mashu then sucked this supernatural essence from the patient's abdomen.*

Natu



nd the Camera

These are the prizewinners and selected honorable mentions in Natural History's *first Photographic Competition. A complete list of winners and honorable mentions can be found on page 78. At left is the First Prize winner in the black-and-white category, taken by Mr. David H. Stone of Dartmouth, Nova Scotia.*


Keith Gilchrist


Keith Axelson

Terry

Alfred Fredette

Frank Strnad

Leo LeBon

Ann Bartlett

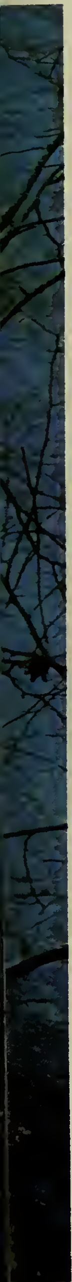
Patricia Drew

Robert Gray

Patrick Grace

Frank Lerner

William Bake

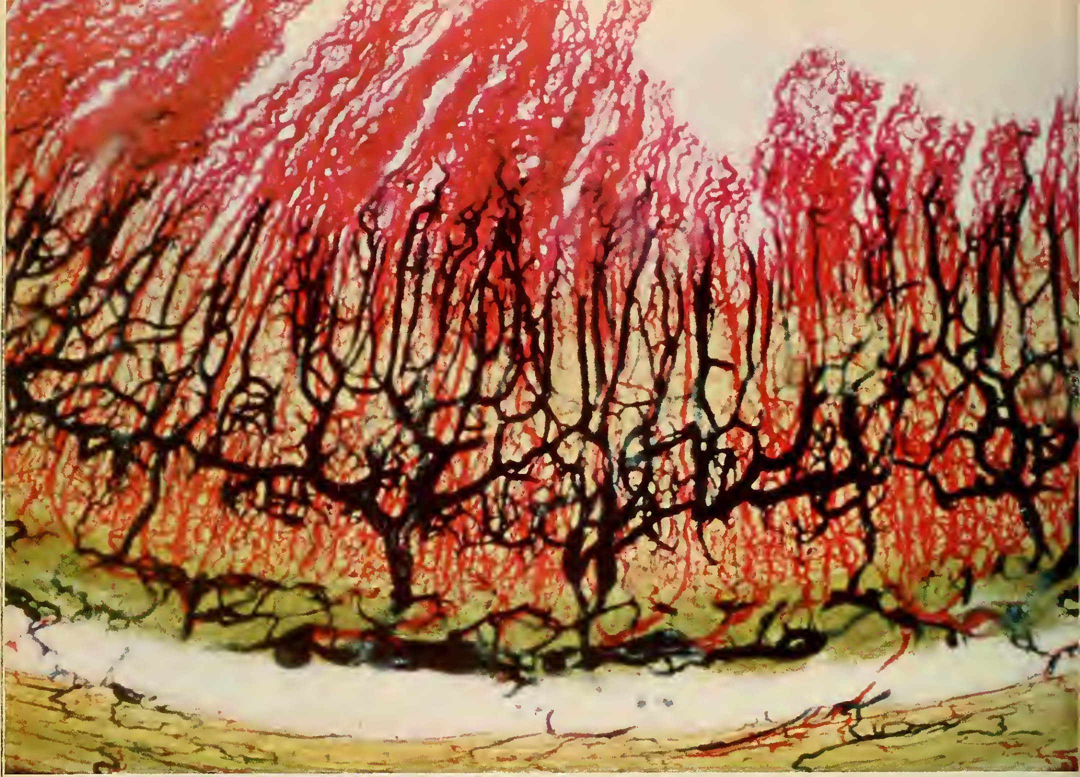


William Duesing

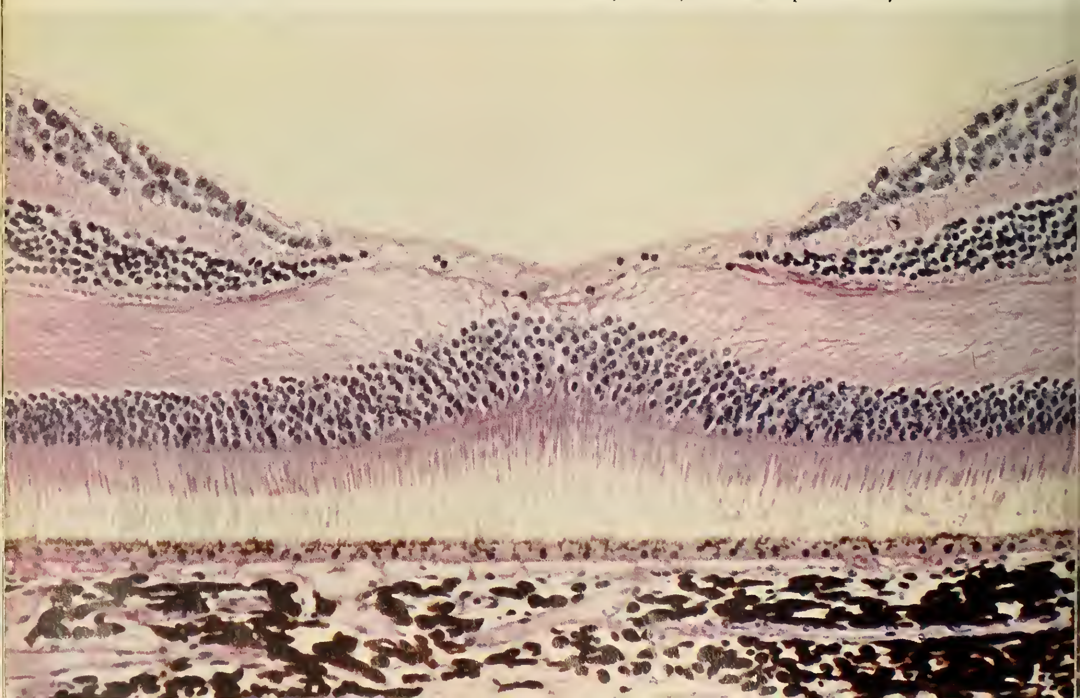
Robert Zwickel

Lorrimer Armstrong

The First Prize for color
was awarded to Alfredo MacKenney,
The volcano is Pacaya, in Guatemala
where Mr. MacKenney lives.
The Grand Prize winner,
at right, was taken
by Mr. Leslie Crine
of Port Jervis, New York.



Neither a forest fire nor a landscape but, above, the small intestine of a cat (injected specimen) and, below, a stained specimen of mammalian retina.



Hooked on Histology

Some families take examinations nonchalantly—in their stride—but they are in the minority. By the time my fourth daughter had passed "0" levels (equivalent to American high school examinations), I felt rebellious. Moreover, I had formed the view that the types of tests devised by the appropriate authorities in Britain today assess the size of the child's bottom rather than that of its head. Further they insure that, during the most creative period of the adolescent's life, he continues to learn by rote knowledge acquired in the past by others. Thus, in order to assist the pedagogues in their selection of "future" ability and talent, the fruits of this valuable period are lost altogether or drastically curtailed. The examination system today is a long-drawn-out and exhausting process by which memory, intelligence, and intellect are selected at the expense of enthusiasm, originality, and creativity.

As a parent one watches the process with something akin to despair. After the fourth child had been ground through "0" levels and a new horror, "A" levels (university entrance exams), was in the offing, I decided that a few experiments were required. It seemed to me that very little of the knowledge crammed into pupils for "A" level examinations would ever prove of the slightest use to them afterwards. The objective, therefore, was to help them learn the facts as easily and quickly as possible, to retain them over the period of the examination, and to do so without developing a permanent loathing, or a feeling of intense boredom and irritation, for the subject. We first turned our attention to histology. As a student I had been rather bewildered by this course. I used to peer down my microscope and examine the conventional cross sections of bone, of injected gut, of squamous epithelium—and not have the slightest idea what I was looking for. The diagrams on the board or the figures in the textbook of the day helped little or scarcely at all. I realized that for the purposes of "A" levels and "S" levels (university scholarship examinations) it was essential to cut down the period of fumbling down the barrel of a schoolroom microscope with one's eyes. Secondly, some method had to be devised whereby one could pick out the distinctive features of the preparation from the bewildering plethora of cells and nuclei, impress them upon the mind's eye, and memorize them. Finally, the necessary knowledge must be acquired in such a way that the fantastic beauty of the histological slide remains a source of pleasure and delight—not a memory of hideous frustration or the boredom of learning by rote.

While I was turning this problem over in my mind, I came across some photographic preparations in an exhibition of microscopy at Oxford. I realized that I had fortuitously arrived at a solution. These photographs were simply 35 mm. transparencies of standard histological preparations, but the photographer, Gene Cox, was clearly an artist as well as an excellent technician. It was their artistic quality that elevated these photographs out of the morass of mass reproduction and turned them into first-class visual aids to learning.

I selected a few examples, which particularly caught my fancy and which are illustrated here, and asked if I could borrow them. At home I projected them onto a wall without bothering to pull the blinds. The children were immediately interested. "But that's a forest fire!" (actually the injected gut of the cat); "That looks like a sort of desert landscape" (retina of mammalian eye); "Somehow that reminds one of a pop guitar" (organ of Corti). I realized they had learned three histology "spots" in three minutes, and in a way that would carry them through the stupid type of exams in which they were embroiled.

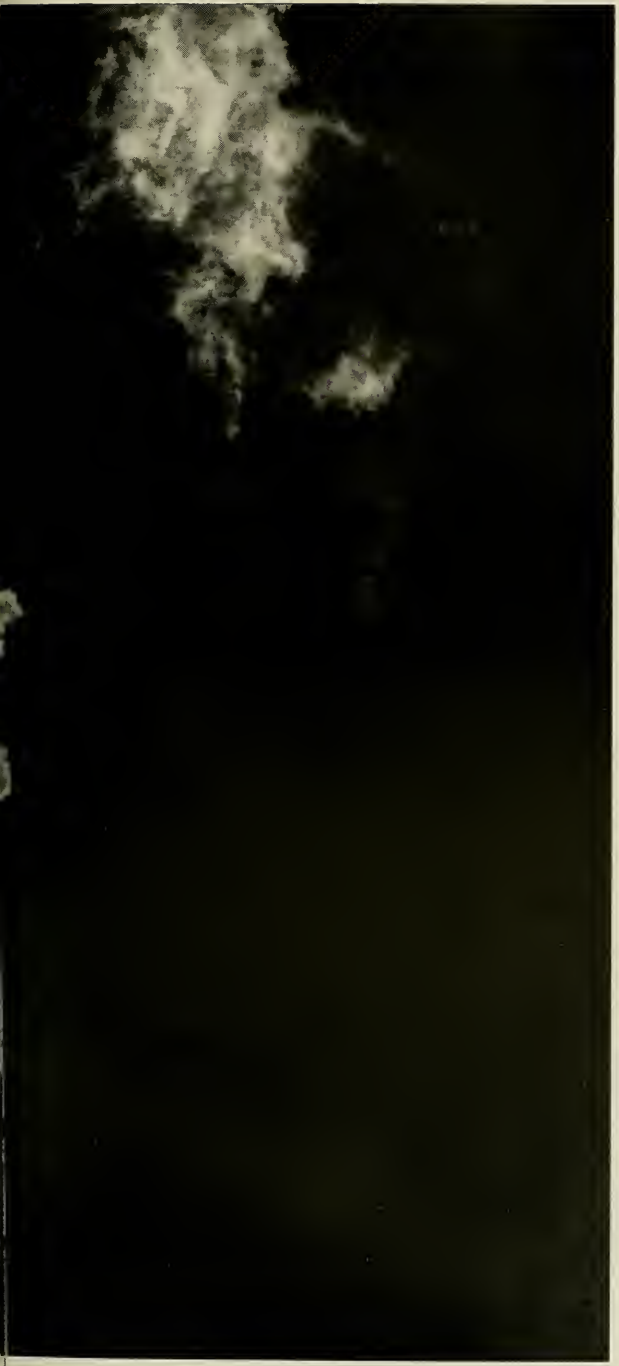
A full set of histology slides geared to "A" level, or first university year, is an expensive item for any home, even if it already possesses a projector. We did buy such a set, however, as a joint Christmas present for the potential "A" level candidates, and when the examinees were through they sold them without difficulty to the biology teacher in one of their schools.

The family constitutes rather a mixed bag, both with regard to their intellectual capacity and their ultimate scholastic and career objectives. We have among us a would-be singer, a philosopher, a social scientist, a farmer, an art historian, and a biochemist. One of them eventually notched up 99 per cent in the histology spot exam, but what seemed more important was that everyone managed to zoom, canter, or scrape through. I came to the conclusion that, through the use of the slides, there had been an over-all improvement in performance, regardless of the range of ability. Furthermore, it was not just a case of "listen and forget, look and learn" but "like and learn *fast*." So much for the children's examinations. For a moment one could relax and philosophize a trifle smugly on visual aids and the rapid acquisition of knowledge. But without realizing it I had, in the process, been irrevocably recaptured and refascinated by the sheer beauty of histology. I just had to go on.

Somewhat ruefully, I began to relearn a bit about section cutting and staining, and to take color photographs of the results. In the end it took about four years to mug it all up. Inevitably the new techniques were applied to the flea, an insect which had caught and held my attention for several decades. After experimenting with my own equipment I bought a new microscope with a built-in camera.

Obviously one takes these colored micrographs in order to achieve a definite scientific objective: to illustrate some obscure point about the structure or function of the part in question and to pass on the information clearly and unequivocally. But this is partly rationalization—about midnight, the house grows silent, there is a last clink of spoons against mugs of Ovaltine, a tap runs, a door slams, the exam-crammers and the T.V. fans retire to bed. Even the dogs abandon their heroic and maddeningly vociferous defense against imaginary burglars. Then the microscope light is turned on and the appropriate blue filters inserted; a wholly delightful and leisurely excursion through the cell world begins. I don't pretend to understand the strange esthetic satisfaction and somewhat infantile excitement gained by recording these dreamlike, almost surrealist "landscapes" of purple cells, violet and scarlet proteins, sky-blue and golden cuticle. This is a mescaline-like world of fantastic colors and timeless beauty. At least I am sufficiently honest not to delude myself: this is not science, it is pure escapism and undiluted pleasure.

by Miriam Rothschild



For Cloud Watchers

by Richard M. Romin

The sky is like a vast, overhead movie screen. Passing across this screen almost every day are hundreds of pictures made of clouds. Changing weather conditions account for the wide variety in this display. The clouds we see may remind us of gray monsters, or white horses' tails, or cream puffs, or cauliflower. We are looking at a traditional "mackerel sky" when it has high-flying clouds lined up like the pattern on a mackerel's back. The aeronautical age has produced nomenclature that also uses simple analogies: aviators say they fly through "soup" and among "woolpacks." And the cloud show can become dramatic indeed, when it is accompanied by such related phenomena as thunder and lightning, rain or snow.

The imaginary pictures we see overhead are based on the realities of physical chemistry. Every cloud is composed of tiny water droplets

or ice crystals. And just as a Hollywood motion picture has a title, so do clouds, although they are named in a more technical way. Clouds were first classified in 1803 by Luke Howard, an English pharmacist. This observer divided all clouds into three basic groups—*cumulus, cirrus,* and *stratus*—and his system is still used throughout the world.

Although he was being technical, Luke Howard, too, must have been seeing pictures made of clouds. Cumulus is the Latin word for "heap," cirrus means "lock of hair," and stratus is derived from the Latin *sternere,* "to spread out." In other words, cumulus refers to puffed-up clouds; cirrus to the wispy kind; and stratus to those that take the form of layers, or sheets.

Modern weather scientists have modified Howard's classification to make it more specific when identifying the family to which a cloud belongs. These meteorologists consider not only the cloud's shape but also its height above the ground. Another modification makes use of the affix "nimbus," which is added to the names of those clouds that produce rain or snow.

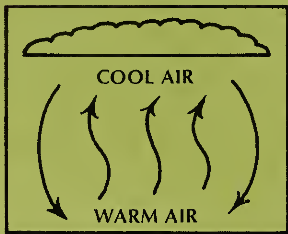
In terms of altitude, clouds in the lowest range are those that have their bases less than 6,500 feet above the ground. These include the cottony puffs of cumulus and their stormy big brothers, which are named by combining cumulus and nimbus, hence cumulonimbus clouds. A flattened version of the low-altitude cumulus cloud has a special name, stratocumulus. In the low-altitude group are also layers of stratus clouds and the dense, murky rain providers called nimbostratus.

When its base is at a height of from 6,500 to 20,000 feet the cloud is in the middle domain and the identifying affix now is "alto." Here, white clumps of altocumulus roll across the sky, sometimes in parallel bands; here also, milky altostratus layers dim the sun, thereby serving as predictors of rainy weather.

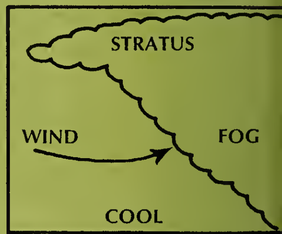
The highest water-made clouds, and also the most gossamery in appearance, are those extending from 20,000 to 30,000 feet or more above ground. Their delicate appearance results from their ice crystal structure and the action of strong upper winds that comb them out. In this domain the several varieties are all of cirrus.

This Latin word for "lock of hair" is not forbiddingly restrictive; cirrus can also take the form of hooks or stalks of wheat, and the wispy waves are frequently called "mare's tails." The cirrostratus variation, which invades the sky with a thin veil, sometimes means bad weather ahead; at other times, it refracts the sun's rays and forms a bright ring of light—a halo—around the solar disk. Cirrocumulus clouds are less common; these are the ones with a pattern that appropriately suggests a "mackerel sky." Amateur forecasters have been aware for a long time that cirrocumulus clouds are emissaries

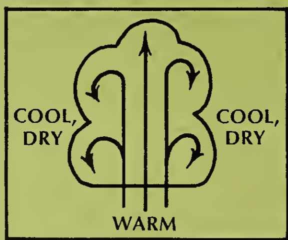
Four Ways Moist Air Rises To Form Clouds



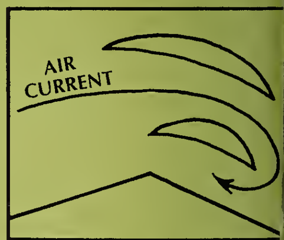
Fog formed at earth's surface is stirred by the wind and rises, becoming a layer-type stratus cloud.



Through convection, thermal air current takes moist air into cool, dry atmosphere. The result is a cumulus cloud.



Slow, steady ascent of warm, moist air to cooler heights condenses water vapor into droplets, forming a cloud.



In orographic lifting, air rises over hills or mountains. Cooling produces lenticular (lens-shaped), or wave, cloud.

For Weather Guessers

Cumulus and stratocumulus clouds indicate unsettled weather.
Cumulonimbus clouds produce showers, thunderstorms, and ha
Altocumulus, especially if lenticular, come with windy conditi
Stratus can accompany fog, rain, sleet, or snow.
Nimbostratus are associated with continuous snow or rain.
Increasing altostratus frequently precede steady precipitation.
Cirrus clouds invading the sky mean almost certain rain.
Cirrocumulus clouds are emissaries of a stormy warm front, especially when they thicken into cirrostratus and altostratus.

of storms, especially when they blend and thicken into cirrus, cirrostratus and altostratus. To these observations we owe such rhymes as:

Mare's tails and mackerel sky,
Not long wet, nor not long dry.

and

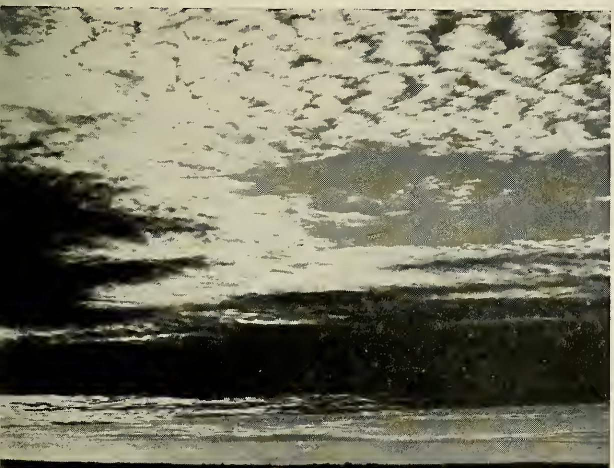
Mackerel scales and mare's tails
Make lofty ships carry low sails.

Whatever the type of cloud, its origin is the gaseous, invisible water vapor in the air. This vapor is always present to some degree. It is what we call humidity, and is supplied by vegetation, by bodies of water such as lakes and rivers, and by rain itself. Moving air carries this vapor upward. Rising to higher levels, where the atmospheric pressure is less, the air expands and in doing so, it also becomes colder. This cooling condenses some of the water vapor. The result is the production of small droplets of water that make up a visible cloud.

Tiny particles already suspended in the atmosphere help to form these droplets from the condensing vapor. Some of these particles are microscopic bits of dust from the land or salt crystallized from spray thrown up by the sea. Others, too small to be seen even through a microscope, are the electrically charged molecules known as ions. Meteorologists term these makers of droplets, whatever their size, condensation nuclei.

When the cloud's droplets form at altitudes high enough to provide freezing temperatures, they usually go on to become ice crystals. These crystals may join together and build up into clusters. When these become too heavy for the air to support them, they begin falling to the earth, melting into raindrops on the way down. On the other hand, if the freezing temperature is close enough to the ground, the droplets turn into six-sided snow crystals. But much still must be learned about precipitation. For example, in tropical areas large droplets form around "giant" condensation nuclei (the largest are only 0.0004 of an inch in diameter) and then join together, or coalesce, to give rain showers directly, without need for freezing and then melting.

rrus above: the "mare's tails" have company—a jet plane's trail.
tocumulus below: this lenticular kind takes the shape of almonds.



Now let us return to a basic question: What makes the air rise to form clouds? Meteorologists give at least four possible causes of the upward motion. Usually, they say, the air ascends because it is pushed up by cooler air descending from higher altitudes. The cool air descends because, in accordance with the gas laws of physics, its lower temperature makes it denser and, therefore, heavier. Gravity pulls this air down to the surface, where it displaces the relatively warm, lightweight air. This is a slow, steady process that can result in a "front," a broad zone of separation between relatively cold and warm air masses. When a cold air mass advances under a warmer volume of air, the edge of the advancing air mass is a cold front, characterized by cumulus-shaped clouds. When a warm air mass overruns a colder one, the advancing edge is a warm front, which can be identified by the presence of predominantly stratus-shaped clouds.

Winds, too, can force layers of air to rise. If this air is moist to begin with and has already cooled at the surface of the earth, the result is fog. The wind's contribution is to buffet the foggy air and sweep it into the sky. There the fog becomes a stratus cloud. Although stratiform clouds can accompany fog, rain, drizzle, sleet, or snow, a thin layer of stratus is frequently "burned off" by the sun to disclose clear weather above. It

has been said that a stratus cloud in the morning often ushers in some of the finest days we enjoy.

A third kind of rising air current, called a thermal, occurs over surfaces of the earth and sea warmed by the sun. The warmed areas transfer their heat to large, discrete parcels of air just above them. Through the process of convection these parcels, or thermals, pass quickly upward, rising through cooler, drier atmosphere in much the same manner as bubbles rise in boiling water. When the moisture in a thermal condenses the result is a small puff of cumulus.

As thermal convection continues to feed the cloud with heat and moisture, it creates a warm "corridor" through which more air can rise to cooler heights. In this way an insignificant cumulus can build itself up vertically into a tall "towering cumulus" that contains a potential rain shower. Thermals have a rotary motion that makes the cloud appear to boil. Within fifteen minutes, by this process, a cumulus that looked like a small puffball can "boil over" and become a cumulonimbus alive with thunder and lightning.

Another kind of lifting, characteristic of windy conditions, takes place over hills and mountains. As the wind follows the rising contours of the earth, it carries moisture aloft. In this phenomenon, known as orographic lifting, the resultant clouds frequently take the form of the air current. Seen from the side, they may resemble waves, lenses, or fishes.

Such are the four basic processes by which air carries its moisture aloft. They can work alone or together to produce an infinite variety of cloud forms and combinations.

Now suppose we spend two or three days observing the sky during the approach and passage of a typical warm front. This means we start with a cold air mass around us. The air behind the front is comparatively warm. What kinds of clouds do we see as the boundary between cold and warm air approaches?

Our first clues to the warmer, wetter weather ahead are a few fine threads of cirrus. They have gradually formed along the high leading edge of the front. Behind them trails a filmy sheet of cirrostratus, which soon coats the entire sky. Although the lower portions of the front may still be as much as a thousand miles away, the high leading edge of the advancing weather system, indicated by the cirrostratus, is directly above us, like the windblown crest of an impending wave.

In a few hours we see the clouds slowly descend below 20,000 feet and become milky, translucent altostratus. While the clouds are thickening, the pale sky is turning a dull white. When six-tenths or more of the sky is covered with opaque clouds, we have a so-called ceiling.

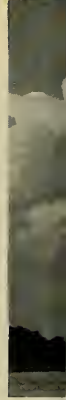
Within twenty-four hours, the darkened underside of the lowering layer begins to roll and heave. Ragged spots of fractostratus (from the Latin *fractus*, "broken," indicating a ragged mass) usher in the first few drops or snowflakes. The base of the cloud cover comes lower. At about 6,500 feet, the cloud becomes a gray, murky nimbostratus and soon rain, drizzle, or snow begins falling in appreciable amounts from the shapeless belly of the overcast. The precipitation may continue for hours or days.

The passage of the front is marked by a shift in the wind, a rising temperature and a clearing sky. However, atmospheric changes do not come to a stop with the passage of the front. Weather is a continuing process. We have it year after year; it is dynamic, changing from minute to minute. The appearance of the sky during a frontal passage will vary with the seasons, the location (for example, the east or west coast of the United States), and the direction of the strong upper winds, which blow clockwise around areas of high atmospheric pressure; counterclockwise around low-pressure centers.

When the warmer air takes over, flat-bottomed puffs of cumulus may appear. But as we have seen, these innocuous-looking woolpacks have a way of quickly building up to towering cumulus. Of these column-like versions of cumulus, a weather poet has observed:

> When clouds appear like rocks
> and towers,
> The earth's refreshed by frequent
> showers.

And strong convective currents may



just as quickly heap these lofty cumulus into enormous cumulonimbus monsters—the most powerful and violent of all clouds. These are the ones responsible for heavy rain showers, thunderstorms, hail, and tornadoes. The air currents within these giants create severe downdrafts and updrafts. Flying through them is extremely dangerous. In their most advanced stages, they develop a typically anvil-shaped cirrus top. Their bases are frequently skirted by shaggy remnants of fractocumulus. Radar observations and pilots' reports have indicated that the tops of some cumulonimbus clouds might extend up to 60,000 feet.

All these cloud phenomena are not new, but today's meteorologists are finding new ways to study them.

The threatening thunderheads at left belong to the cumulonimbus variety, which produces thunderstorms, heavy showers, hail, and tornadoes. Nimbostratus are a dense, low-hanging type of rain producer, shown in the farm scene at lower left. Clouds found at two different altitudes are seen in the photo below. At the bottom are a group of stratocumulus. The windswept clouds above them are altocumulus.

'hey are observing clouds through adarscopes and by means of photoraphs transmitted from weather satllites. To understand what is really appening with clouds, they are iewing them as concentrated collecions of electrical charges. They are tudying the effects of "seeding" louds with artificial condensation uclei. They are using data computrs to get mathematical "pictures" of loud structures. These modern nethods of contemplating clouds oint the way to more accurate preictions of the weather. They also ouse hopes that man will eventually earn how to control it.

In the meantime the show goes on, nd the sky's motion pictures connue to fascinate amateur and proessional cloud watchers alike.

The Wine Grape, U.S.A.

by Henry M. Rubin

About the beginning of the eleventh century the prow of the Viking ship of Leif Ericson slipped through the fog banks off the coast of Labrador and headed toward the mainland. There Leif found such an abundance of wild grapes that he gave the land the Norse name Vinland. Whether the historical reconstruction is fact or myth, one thing is certain—grapes were plentiful. After this first known reference to the grape in the Americas, there followed a historical hiatus of more than half a millennium until Captain John Hawkins wrote, in 1565, of finding grapevines growing profusely in Florida. A few years later, scouts sent out by Sir Walter Raleigh described the Carolina coasts as being "so full of grapes . . . in all the world the like abundance is not to be found." In 1606, Captain John Smith reported on the good wine made in Virginia.

On the other side of the continent, vine cuttings from the old country were established in Mexico as early as 1524. About 1769 vines were finally brought to California by Fra Junípero Serra who founded the first of the chain of Franciscan missions along El Camino Real. Indians, keeping their balance with poles, crushed the grapes by jumping on them; thus, wine was made for the sacrament and to answer the Mediterranean taste of the early friars.

Due to this double line, the native grape of the east coast and the vine from Europe introduced in the west, there is not a "single" wine of the United States, but rather two wines—so different that they are not comparable, yet so intertwined that they cannot be considered apart. Grapes in the west are now grown on the rootstock of the eastern vines; the wines of the east are frequently blended with those of California to modify their flavor and raise their alcoholic content. As one example, all the dessert wines of the east are fortified with California brandy.

The genus *Vitis,* which includes all cultivated grape-producing vines, has two main species. *Vitis vinifera,* the grape grown in California (and fron which all the wines of Europe are made), probably had its origin in ancient Asia Minor. *Vitis labrusca,* the main vine grown east of the Rockies (and in the state of Washington), is the native American grape. The *labrusca* grape is physically distinguished by its slipskin quality, for when this grape is squeezed it pops out of its skin, as opposed to the *vinifera,* which does not.

Thus, there are two stories of wine growing in this country—of east and west, of the native and of the import.

Although the early colonists found a profusion of grapes along the Atlantic seaboard, most of the fruit was small and hung in small clusters. The juice was low in sugar and high in acid. With a completely European-oriented attitude, the would-be growers uprooted, plowed under, or simply ignored the native vines and instead planted cuttings from France, Spain, and Germany. These imported cuttings, however, quickly died of various causes in their new environment—from insects such as phylloxera, or root louse, from molds, or from extremes of temperature.

These unsuccessful efforts to grow *vinifera* grapes in the east started early and lasted for a long and disappointing time. Queen Christine, in 1645, instructed John Prince, her governor of New Sweden, to encourage "culture of vine and give industry his personal attention." Two years later, Richard Nicolls, first governor of New York, granted Paul Richards of Long Island a grape-growing monopoly for the colony. Alexander Spotswood, Governor of Virginia in 1710, even went so far as to bring over a colony of Germans from the Rhine River wine area to his Spottsylvania County. All attempts ended in failure.

By the early 1800's, serious attention was being given to the native grape. Experimentation and selection began. There are only poor records of what was done, what selections and what crosses were made, but the first superior hybrid grape was the Alexander, which Thomas Jefferson recommended in 1809. This variety has since faded from the scene, as other varieties were developed that ripened at more opportune times, and ha

ore desirable skin colors and better ıgar content.

In 1880, with a population of a tle more than fifty million, the pro- ıction of wine in the United States ıs 19 million gallons, or about four- ıths of a gallon for each man, ɔman, and child. The growing area ıs extensive. Missouri was the larg- t producer, then Ohio, each made ɔre than a million gallons. New ɔrk contributed almost half that ıount, and Alabama's yield that ar was 422,000 gallons. Even Texas oduced 35,000 gallons of wine.

This very sizable production came ɔm thousands of small plots, mainly ree to ten acres each. But even then, ɔ small grower was being pushed t as a vintner. The imposition of enses and bonds, the levying of ıvy taxes, the growing competition ɔm cheaper California wine, and a ɔwing taste for hard liquor were factors that contributed to his ɛntual demise.

Toward the end of the century the ıin locations of high-quality grape ɔwing shifted to a pattern similar that of today. Two main areas of tern production emerged. The first s the Chautauqua region, with its ncord and Niagara grapes—a strip ır miles wide and about a hundred les long, on the shore of Lake Erie Ohio, Pennsylvania, and New rk. This area extends no farther ınd because the vines' existence ɔends on the ameliorating effect of lake's waters on the temperature remes. The second. was the Finger ces area of New York, whose main ıpes were the Catawba and the laware.

With the start of the Gold Rush, in 19, California's vineyards and ıe industry began to flourish and oy prosperity, until a nationwide ɔression hit the state in 1876. Vint- s who bottled premium wines with ognized and established labels re not too badly hurt, but wine was ng sold by others for as little as cents a gallon.

The general financial crisis, with tightened credit restrictions ıught the industry close to disaster. ıding to aggravate the problem re overproduction, wrong grape ieties, poor quality control, and ɛs of spurious and adulterated products. The crisis had one good effect, however. Many incompetent vintners were forced out of business.

In 1869, the Buena Vista vineyard north of Sonoma was the first to be struck by a new disaster, the root louse phylloxera, which was already decimating the wine-growing regions of Europe. It soon spread throughout the state. To this day there is no known cure for this pest, but it was soon discovered that the roots of the native *labrusca* vines were safe from the louse. Resistant rootstock of *labrusca* was brought from the east, and the laborious, time-consuming job of planting and grafting the *vinifera* cuttings began. Today, almost all vines in California's premium wine-growing areas use premium *labrusca* rootstocks.

The extremely varied climate of California has permitted vineyard development in three main areas. In the south, around Cucamonga and Ontario, there is a small area producing table wines of medium quality. The hot San Joaquin and Sacramento valleys of the interior are heavy producers of both bulk table wine and the best fortified dessert wines, as well as the source of all grape brandy. The cooler north-coastal district, which radiates in a crescent around the Bay of San Francisco, is the source of the state's finest table wines.

From about 1885 quality began to receive increasing attention. At the Paris Exhibition of 1889, California wines won 35 gold, silver, and bronze medals. Because of the phylloxera devastation on the continent during the 1800-1900 period, imports to the United States were slight, and wines from California began to make some impact on the national market. The culture and economics of wine were growing but the opposition was formidable. Milk, soft drinks, and hard liquor were the competitors and the puritanical Protestant ethic was the ideological foe. The latter triumphed, and when national Prohibition became the law in 1919, a final seal was put on the industry's growth.

When the Eighteenth Amendment was repealed in 1933, the wine industry was almost in ruins. A few wineries were in minimal operation making sacramental wines. Equipment had deteriorated, cooperage was dried out and broken. There were almost no experienced wine makers. The acreage of fine wine grapes, particularly in the west, was almost non-existent. Many vineyards had gone to weeds and rattlesnakes, some had been replaced by orchards and other crops, and others were replanted with table grapes.

What few wine-drinking patterns had existed before Prohibition, disappeared. The exceptions were those few people who had traveled abroad and a few ethnic groups, such as the French and Italians, who had survived Prohibition and its affront to their cultural heritage by making wine at home. Actually there was a great deal of home wine making, since it had remained a legal activity. A California growers' organization known as Fruit Industries, Ltd. was formed and with a loan from the federal government began concentrating grape juice. This concentrate was sold for home use, where it was diluted with water and innoculated with wine yeast. A sales representative for the company would even come to the house with the product and service the order—start the wine fermentation, filter, bottle, and even label the wine.

But the first post-Prohibition wines did little to stimulate real interest in wine. There were a few good ones, but these were exceptions. From the magnificent vintages of 1934 and 1936 a small amount of Cabernet Sauvignon of the highest standard was made in California's Napa Valley. And in anticipation of repeal, small amounts of wine had been made under bond. But by and large, the wine industry ruined its own chances by dumping an inferior product on the market. Economic pressure and ignorance prevented the disunited vintners from admitting that a start-up period was needed to get good wines back into their inventories.

Critical to the improvement that followed was the increased attention given to the study of viticulture. The Department of Viticulture and Enology of the University of California at Davis and the New York State Agricultural Experiment Station at Geneva contributed scientists who devoted their talents to the industry. Competent and dedicated wine makers were trained, better varieties and strains of

Wine Grape Region

The states named on map above are commercial producers of wine grapes. Important wine-producing regions are also named; those growing the native grape, *Vitis labrusca*, are lettered with roman lettering, those growing the imported *Vitis vinifera* grape are in *italics*. States omitted produce little or no wine.

United States

Common Wine Terms

AROMA — That fragrance of wine that originates from the grapes used, as distinguished from "bouquet."

BODY—Consistency, thickness, or substance of a wine, as opposed to a "thin wine."

BOUQUET—That part of the fragrance originating from fermentation and aging.

CASK—Any round, bulging wooden container for wine. Includes barrels, kegs, puncheons, pipes, butts, tuns, hogsheads, all of which signify various measures of capacity in different countries and various products they may contain. A cask used for fermenting wine usually is called a vat or a tank; in this country these two terms are usually applied to containers that are straight-sided rather than barrel-shaped.

CUTTING—A segment of the branch of a grapevine cut during the dormant season and used for propagation of new vines. Most new grapevines are planted as cuttings, rather than seeds or new plants.

DRY — Lacking in sweetness; free of sugar.

ENOLOGY—The study of wine making and the growing of grapes for wine; related to viticulture, which is the science of grape culture.

GENERIC—Names which stand for definite type characteristics of a wine are called generic names. They often have a geographic origin, e.g., Burgundy, Champagne, Sauterne, etc.

VARIETAL—When a wine is named for the principal grape variety from which it is made it is said to have a varietal name.

VINTAGE—Properly refers to the year in which grapes are harvested. In France, traditionally used to specify a particularly fine wine year. In the U.S., most producers blend the wines of several years to achieve a particular balance and thus do not specify a year of harvest.

grapes were created and planted, new equipment was designed, and better viticultural practices were sought and found. Much was achieved in a short time. Today our technology is so developed that Europe sends students to America to study wine making.

Among the many problems that plagued the post-Prohibition industry was a great confusion in the naming of wines. In the west, almost every wine maker had his own label name: Crabb's To Kalon Black Burgundy, Edge Hill Napa Pinot, Chablis of Ben Lomand's Farm. Later came a rash of wines in slavish imitation of European names such as Château Margaux and Château Lafite, a practice now forbidden by federal law.

There is still name confusion. For example, much of the wine produced in America carries European names, such as Burgundy or Chablis. These names mislead the buyer because he tends to believe that "Burgundy" means the wine is made from a certain variety of grapes grown in France. In reality, in the United States, Burgundy simply means that the wine is red. Equally bad is the implication that "real," therefore good, wine comes from Burgundy while anything else is imitation. Thus the quasi-European name tends to "put down" the American wine. It would be far better to label a wine as a California Red or a Finger Lake White. One encouraging trend is the increasing use, wherever possible, of varietal names such as Pinot Blanc or Cabernet Sauvignon, which refer to the dominant grape in the wine.

One of the patterns that distinguishes the wine making of this country is that most vintners make a full line of wines; table (dry), dessert (sweet), and sparkling; red, white, and rosé; the varietal and the generic. In France there are only a few châteaux that make more than one wine. The expressed attitude is that for a thousand years or more, by trial and error, each plot of land has been tested for *the* best grape and the errors of growing and wine making have been eliminated. While the American approach has decided economic advantages, it is impossible to "specialize" in twenty wines to the degree that a European vintner can perfect the qualities of a single wine.

World War II gave great impetus both to the use of wine and to the wine industry in America. During the war, foreign competition ceased; later, the American soldier and his dependants lived for a time in wine-drinking countries where they learned about wine. The trend toward the appreciation of wines was heightened by the mass postwar invasion of Europe by American tourists. Today the situation in the United States is most encouraging both as to the quality of our wines and the improving taste of the American public.

In assessing quality, eastern wines are difficult to evaluate. They are technically sound and well made, but they are different from California and European wines. The wines made from *Vitis labrusca* grapes have a special flavor and aroma that come mainly from the presence of methyl anthranilate. This volatile chemical imparts a character that is described as "foxy" or "musky." It can be recognized by smelling and tasting a bottle of Concord grape juice.

A high percentage of wine drinkers react negatively to this "foxiness." Vintners, therefore, have sought methods to minimize it. Millions of gallons of neutral California wines are imported in bulk for blending purposes. A wine labeled "New York" (state) can legally contain up to 25 per cent out-of-state wine. Vintners have also tried flash pasteurization and longer aging in the wood. They have looked for varieties of grapes with less of the foxiness and have met with limited success in some of the new hybrids.

Another method of diminishing the foxy flavor is called "amelioration"—the addition of sugar to the wine during fermentation. The sweeter the wine, the more the foxiness is concealed. Thus the sweet wines of the east, such as the kosher types, have gained popularity on this basis. Bubbles in sparkling wines accomplish the same purpose.

Wine consumption in the United States is constantly growing. More than 191 million gallons were drunk last year. Of this, 75.5 per cent came from California, 9.4 per cent was of foreign origin, and 15.1 per cent came from the rest of the United States (mainly New York, Ohio, and Michigan). If this seems like a lot of wine, stop and compare our consumption with that of other countries. We use a trifle less than one gallon per year per capita. In France the figure is 33 gallons; in Italy 28. Our annual production of more than 171 million gallons seems large enough, but in the world we rank ninth—behind Italy, France, Spain, Argentina, Portugal, USSR, Algeria, and West Germany, in that order. The revenue derived from wine is a factor in the American economy, especially for California; yet it doesn't compare with France where wine accounts for 8 per cent of the total agricultural revenue, and where the average family spends 8 to 13 per cent of its food budget on wine.

While they do not have to contend with the flavor problems of the eastern winegrower, the California vintners are now faced with a specia problem, that of creeping suburbia The premium vineyards of the state concentrated in the counties aroun San Francisco Bay, are being dis placed by houses, factories, and pave ment. Hopefully, such practices a agricultural zoning will aid the wine growers by holding the "tiger a bay," at least for a while. Meanwhile vintners are making sizable commit ments by bringing into cultivatio new vineyards in counties one step re moved from urbanization, such a Mendocino in the north and Monte rey in the south.

As a family climbs the economi ladder, it spends less money on bee and more on wine and spirits. Win is now a drink with status; each yea more wine columns appear in new papers and magazines. For the win buff, several monthly publicatio are available, and bookstore owne complain that they can't get enoug books on wine to satisfy their cu tomers. There are thousands of am teur wine makers in the country wh with varying degrees of competenc produce their legal limit—two hu dred gallons of wine for home use.

Wines are now easier to fin throughout the United States. A r quest for wine with dinner in a mi western restaurant doesn't automa cally cause a panic or label the cu tomer as "odd." He may be offer only a choice of red or white, t

ine may be served in too small a lass, its name may be mispro-ounced or, more likely, referred to nly by number, but the chances of is getting wine with his meal are ıcreasing. And there is less chance f its having been mistreated.

Generally, the beginning wine rinker starts by liking the slightly veet, low-tannin white wines. Grad-ally his palate becomes more accus-omed to drier and more full-bodied arieties. The old Bordeaux, with a ort of musty quality, may delight ıe sophisticate yet repel the novice. Vhere the original American empha-s was on the fortified, high-alcohol veet wines, taste is shifting in an nmistakable trend toward the dry ıble wines. Because the quality of ıe slightly sweet table wines, such as *in rosé* and *chenin blanc* has dras-cally improved, the sale of these ines has also zoomed.

Comparing the wines of the United tates with those of the rest of the orld is no simple matter. The *Vitis ıbrusca* wines are simply not com-arable. There are no others like ıem; thus they are not in the main-ream of the world's wines. The alifornia wines are beginning to each a recognized position but as-essment can only be approximate, ersonal, and subjective. The white ines in the styles of the German hine and Moselle still leave the ad-antage to Germany. The dry white ines made from the Chardonnay nd Pinot Blanc grapes are still of ightly lesser quality than those of urgundy, but at times they are so ne that, in blind tastings, it is dif-cult to tell the French from the alifornia. The Pinot Noirs (equiva-nt to red burgundies) are far from eaching their potential. The great abernet Sauvignon wines are truly ıagnificent and are surpassed only y the most exceptional of their rench counterparts from Bordeaux. he Italian-derived grapes, such as arbera and Grignolino, frequently roduce wines that surpass those ıade in Italy. The mass-produced merican wines, selling for about ne dollar or less per fifth, are techni-ally sound wines of increasing qual-y, far superior to that of most Euro-ean *ordinaires*.

Whether the scale is tipped for or gainst the American wine is often a matter of taste preference. The French and English wine drinker will opt for the French claret because they have learned to like its particu-lar characteristics. The Californian will often prefer his wines for the same reason.

Wines differ (even from the same grape variety processed identically) because of soil and climate differ-ences. It requires experience, but not a hypersensitive palate, to be able to distinguish, for instance, wines made from Cabernet Sauvignon grapes grown in the Napa Valley from those made from the grapes of adjacent Sonoma Valley. Wines also differ in the proportions of the blend of va-rieties used.

As the American wine industry has come of age, it has had to struggle for acceptance and status; to get the public not only to drink wine but to drink American wine. It is true that just after the repeal of Prohibition the comparisons were invidious to the local product. Long after the quality of native wines had reached acceptable and even excellent levels, the more affluent sections of society were unable to resist the import label's snob appeal, just as ancient Roman aristocracy demanded only Greek wines.

Robert Louis Stevenson wrote, in the last century, that the best Cali-fornia wines were yet to be made. This is still true for all American wines. In the east, improvement may well come from learning to master the growing of *V. vinifera* grapes; in California, by more attention to the ideal location for each variety of grape, as the French have done with the Pinot Noir in Burgundy. Cer-tainly, new strains and varieties, new techniques of growing, processing, and storing can all lead to improved wines. This, together with a more ex-perienced and more demanding pub-lic, should make the wines of the future a finer experience.

Above all, the fear of ignorance should rob no one of the delights of the grape. The dicta and dogmas of the wine snobs should be ignored. Each harvest produces grapes that are different; each crushing produces wines that are distinct. One can learn about, but never really know, wine. As long as the vines sprout anew each spring, all of us are learners.

SKY REPORTER

SPACE TALK? New and mysterious signals from space have been detected for the second time in a year by radio astronomers, some of whom feel the signals could possibly be the work of intelligent beings elsewhere in our Galaxy. Hydrogen-oxygen molecules generated the first group of signals, but the intensities at predicted wavelengths were in unexpected ratios.

Now the excitement comes from a star, midway between Vega and Altair, that is sending out a radio pulse once every 1.3372795 seconds. Three more such sources, nicknamed "pulsars," have been located in widely separated parts of the sky.

The hydrogen-oxygen radiation may be coming from clouds of dust and gas contracting into stars. The pulsars may be old stars collapsing into unimaginably dense forms of matter unknown on earth. But astronomers around the world, while reluctant to speculate, are redoubling their efforts in the knowledge that they may be eavesdropping on another civilization.

Optical astronomers are trying to find a visible object at the location of the radio source. They are examining an eighteenth-magnitude blue star, watching particularly for light variations. The star's visible brightness has not varied by more than half a magnitude since 1950, and its apparent motion among surrounding stars is less than a tenth of a second of arc per year.

Dr. Anthony Hewish of Cambridge University, leader of the team that discovered the pulsars, is inclined to feel that the pulses are coming from a very small, dense white dwarf star. He says the signals have failed to show the changes that would be discernible if the source were, in fact, on a planet orbiting around a star.

ICARUS—TOO CLOSE The asteroid Icarus, a chunk of rock about a half-mile across, will streak past the earth June 14 at a distance of only 4.25 million miles, a stone's throw as astronomical distances go.

Astronomers will be watching it with interest, because it is one of the few asteroids they have been able to keep track of. It sweeps from within 19 million miles of the sun to beyond the orbit of Mars and back every 409 days, and has been charted on a series of orbits since its discovery.

Icarus is so small that despite its close approach it will never appear brighter than magnitude 13, requiring a moderate-sized telescope to be seen. In just four days, June 13 to 17, it will move from near Polaris to south of Arcturus.

There is no danger that Icarus will hit the earth, despite press reports of such a possibility, which apparently started in Australia. But at least one scientist took advantage of the close approach to warn that the story could be different another time.

Harold Masursky of the U.S. Geological Survey said in Washington that more attention should be given to the monitoring of asteroids like Icarus. One could hit the earth with catastrophic results, he warned. Of the 80,000 asteroids large enough to be visible in telescopes, only about 30 are being monitored, he said. But many come "very, very, very close" to the earth.

THE FARTHEST PLANET The planet Pluto is so far away that to an observer on its surface the sun would appear only as an unusually bright star. For nearly 40 years it has been considered the last planetary outpost of the solar system. Astronomers have long suspected that Pluto may not be the last planet. It does not appear massive enough to account for the perturbations observed in the orbits of Uranus and Neptune (NATURAL HISTORY, March, 1967).

Now, a Russian astronomer has offered new information to support this view. Rollan I. Kiladze of the Abastuman Observatory has calculated the planet's rotation period from brightness changes, and its maximum radius from Pluto's failure to occult a star in April, 1965. He concludes that the mass of Pluto cannot be more than about 0.07 that of the earth, much too small to have the observed effect on Uranus and Neptune. If his calculations are confirmed, the perturbations "can be explained only by the influence of some unknown body, perhaps the tenth planet of the solar system."

Whether such a tenth planet will ever be found is another question. It was not found during the 25-year search for Pluto, although if it is of the required size, it should be brighter than Pluto's magnitude of 15.

VENUSIAN VAPOR Venus and the earth are twins in size and mass, circle the sun at comparable distances, and are presumed to share the same origin. Scientists also assume that they have the same general composition, which at once raises the question, "What happened to the water on Venus?"

Last year's space probes revealed that the Venusian atmosphere is almost all carbon dioxide, and confirmed equatorial surface temperatures so high that any water there should be in the atmosphere as vapor.

Dr. Willard F. Libby, a Nobel Prize-winning chemist, suggests that despite high temperatures at its equator, Venus could have massive ice caps at the poles. He says that where the ice caps meet the high temperatures of lower latitudes, small bodies of fresh water may form, offering a habitat for life.

Writing in the journal *Science*, Libby proposes that the slow rotation of Venus means that the planet has no surface winds as we know them on earth. Heated air rises from the surface and cool air descends vertically. There would be far less heat exchange between its equator and its poles, which could allow temperatures cold enough for polar ice caps.

Libby is now experimenting in a special greenhouse to see what forms of life, if any, can exist in an atmosphere so rich in carbon dioxide. It seems wildly improbable, but the possibility of life on Venus has yet to be ruled out.

JOHN P. WILEY, JR.

CELESTIAL EVENTS

First-quarter moon is on June 3, full on the 10th, last-quarter on the 17th, and new on the 25th. In July, first-quarter occurs on the 3rd, full on the 9th, last-quarter on the 17th, and new on the 25th.

Jupiter is an evening star throughout June and July, setting earlier each evening. Saturn is a morning star, rising into the south about dawn. Venus moves into the evening sky and Mars into the morning sky in June. Mars is too close to the sun to be seen, however, but Venus will set late enough by the end of July to be seen in the late dusk, low in the west.

June 2: The bright object near the moon is Jupiter.

June 9-10: Perigee spring tides will occur with the full moon. High tides will be higher than usual.

June 19-20: Saturn is the bright object near the crescent moon in the morning sky. Venus, at superior conjunction, enters the evening sky on the 20th.

June 21: The sun arrives at the summer solstice at 3:13 A.M., EST, and summer begins in the Northern Hemisphere.

July 2: Earth is at aphelion, the point in its orbit most distant from the sun, about 94,455,000 miles.

July 11: Mercury, at greatest westerly elongation, may be seen as a morning star, low in the east, for about a week before and after this date.

July 17: Saturn appears just below the last-quarter moon in the morning sky.

July 27: Jupiter is near the early crescent moon.

July 29: The weak meteor shower known as the Delta Aquarids reaches maximum today, with no moon to interfere with early morning observations. The radiant in Aquarius is well up in the southeast by 1:00 A.M.

THOMAS D. NICHOLSON

Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on June 1; 9:20 P.M. on July 1; and 7:25 P.M. on July 31; but it may be used for about an hour before and after those times.

a shaman at the death of a former apprentice who had originally received them from him. Besides receiving "old" magical darts unexpectedly in this manner, the shaman may have *tsentsak* thrown at him by a bewitcher. Accordingly, shamans constantly drink tobacco juice at all hours of the day and night. Although the tobacco juice is not truly hallucinogenic, it produces a narcotized state, which is believed necessary to keep one's *tsentsak* ready to repel any other magical darts. A shaman does not even dare go for a walk without taking along the green tobacco leaves with which he prepares the juice that keeps his spirit helpers alert. Less frequently, but regularly, he must drink *natema* for the same purpose and to keep in touch with the supernatural reality.

While curing under the influence of *natema*, the curing shaman "sees" the shaman who bewitched his patient. Generally, he can recognize the person, unless it is a shaman who lives far away or in another tribe. The patient's family knows this, and demands to be told the identity of the bewitcher, particularly if the sick person dies. At one curing session I attended, the shaman could not identify the person he had seen in his vision. The brother of the dead man then accused the shaman himself of being responsible. Under such pressure, there is a strong tendency for the curing shaman to attribute each case to a particular bewitcher.

Shamans gradually become weak and must purchase *tsentsak* again and again. Curers tend to become weak in power, especially after curing a patient bewitched by a shaman who has recently received a new supply of magical darts. Thus, the most powerful shamans are those who can repeatedly purchase new supplies of *tsentsak* from other shamans.

Shamans can take back *tsentsak* from others to whom they have previously given them. To accomplish this, the shaman drinks *natema*, and, using his *tsentsak*, creates a "bridge" in the form of a rainbow between himself and the other shaman. Then he shoots a *tsentsak* along this rainbow. This strikes the ground beside the other shaman with an explosion and flash likened to a lightning bolt. The purpose of this is to surprise the other shaman so that he temporarily

ued from page 33

forgets to maintain his guard over his magical darts, thus permitting the other shaman to suck them back along the rainbow. A shaman who has had his *tsentsak* taken away in this manner will discover that "nothing happens" when he drinks *natema*. The sudden loss of his *tsentsak* will tend to make him ill, but ordinarily the illness is not fatal unless a bewitcher shoots a magical dart into him while he is in this weakened condition. If he has not become disillusioned by his experience, he can again purchase *tsentsak* from some other shaman and resume his calling. Fortunately for anthropology some of these men have chosen to give up shamanism and therefore can be persuaded to reveal their knowledge, no longer having a vested interest in the profession. This divulgence, however, does not serve as a significant threat to practitioners, for words alone can never adequately convey the realities of shamanism. These can only be approached with the aid of *natema*, the chemical door to the invisible world of the Jívaro shaman.

Let your class get close to your demonstrations.

Books in Review

Pure Renaissance

by Jerome Lettvin

THE DOUBLE HELIX, by James D. Watson. *Atheneum Publishers, $5.95; 226 pp., illus.*

In an earlier time Watson and Crick might have fought with swords rather than with words, and irritated popes in place of administrators. Their piecing together of bases to sculpture a self-copying molecular system is pure Renaissance, as is their handling of colleagues. There is almost a Celliniesque flavor about *The Double Helix*. Still, I think this book is more important than simply the show of golden thigh and clay foot. It will have a strong and salutary effect on young students, for it emphasizes the esthetic in science.

Much of science as it is now taught pretends to a sterile positivism. This is most the case where it ought not to be, as in psychology. Students are drilled to value a steady, slow amassing and rumination of data as the road to truth. Histories of science praise drudgery, and Baconian homilies inspire the teachers in intermediate schools (but nobody remarks that Bacon never discovered anything). It has become a widespread belief that science is unrelated to the other arts. Where the artist is inspired, the scientist is merely convinced; where the artist creates, the scientist discovers; where the artist

James Watson and Francis Crick in front of their DNA model

imagines and confects the beautiful, the scientist only digs up and cleans off the true. Watson's book helps dispel such superstitions.

Science and technology are the characteristic arts of this age; just as painting, sculpture, and architecture graced the Renaissance. We are now in a time very like the last part of the seventeenth century. In all earlier periods, there was no distinction between science and the other arts in terms of opposed disciplines. For science arises from the same esthetic impulse that moves all art and it is subject to the same general laws of taste. Most of what is published is, in the main, dull; just as what is drawn, say, by advertising artists or written, say, by literary critics. But a great idea in science is like the inspired moment in any other art. The world is suddenly changed then. A new order stands forth, a new complex of relationships whereby parts of the phenomenal world are connected. In this way, poems and theories are much alike, as are paintings and experiments.

Such considerations sound like the cant of a tired and interdisciplinary eunuch, who suns himself at think tanks and is read by the loyal followers of Will Durant. They can hardly impress an active young student who, sensibly, is not introspective or historically minded, who would rather remake the world than write footnotes, wants to beat Watson, Feynman, Schwinger, and Woodward at their own games. For him Watson's book is important, for it exhibits directly what others only write about secondhand: it is an account of the circumstances of a recent great discovery. How is it—to put the matter in the worst light—that a man with little mathematics and less chemistry can show that doubly screwed molecules carry a code to life? Far too many reviewers have treated the discovery as a lucky accident, for at least several other workers would have found the same thing within a matter of weeks—most notably, Linus Pauling himself. But that is all beside the point of the book.

First of all, Watson shows that the origin of his and Crick's discovery lay in their having a passionately held and strongly intuited view of the problem before they knew of many of the experiments. Thus, contrary to the teachings of the Establishment, it is the boldly imagined form, rather than the cautiously inferred relationship, that takes priority. Watson makes it clear that he and Crick first guessed at the helical structure of DNA for no other reason than that it seemed the most fitting form for long molecules to have when their parts were almost iterative. This is not a judgment based on reason or even on experience with Tinker Toys—

it is somewhat more like a revelation, it is an overriding hunch. Such a revelation, as opposed to a purely metaphysical one, can be used to drive experiment or theory on until either the proper forms emerge or until it can be shown to be no more than an idle conceit. But underlying it are strong feelings of symmetry, simplicity, and economy that are more matters of taste than of logic. The student learns that in the hypothetico-deductive method, the hypotheses take priority and can be as imaginative as one likes. This is far better than experimenting with no clear purpose.

Watson's second message comes indirectly and concerns an ethical matter —how scientists behave toward each other. In this case, the questions are sharpened by the short times involved. On the one hand, in an ideal world everything that is done ought to be open —subject to discussion and criticism. Thereby ideas are sharpened, new ones occur, old and improper ones are dismantled. On the other hand, there is a kind of pride in one's work, the feeling that "I did it and it's beautiful," that makes one hold on to his work, hiding it in his bosom like Zarathustra until it is made to cry loudly in the world not only its own virtue but its author's name. And in science, as in anything else, there are pirates; some strike with such speed that their reputations are for clear thinking, while their victims are thought to be paranoid. All this is not very important if you are lucky enough to have carved out a field for yourself that nobody else has even thought about. It is very much to the point, however, if there is strong competition, as was the case in the early fifties with respect to DNA. Watson and Crick enter as amateurs, handicapped by poor experimental skill, but with the advantage of a theoretical bias conditioned, in part, by the new flowering of interest in informational processes. Chargaff's data show equalities not mentioned in his conclusions. Wilkins and Franklin have crystallographic evidence that they think ought not be let out of the laboratory, but which gets bruited to Crick and Watson. Pauling, also sure of a helical structure, is distracted by an error in his chemistry that he does not catch. Crick and Watson learn of relevant findings by accidental hearsay—a friend remarks that certain molecular shapes are impossible, others possible. All that is happening becomes of vast consequence, and they panic that the others will see the consequence of their own work first. In the end, because they are looking for a particular form they see it before the others, the experimenters, are led to it.

Question: Did Watson and Crick act

improperly? For my part I do not think so, and in this I am at variance with some of my friends. It would have been different if they had known that someone else had discovered the double helix, and were rushing to beat him. But nobody denies that, indeed, they saw it first in the proper detail. It does not matter that someone else would see it a week or a month later; the priority is Watson's and Crick's. They won a race that was admittedly a race, and it was understood that the winner would be rewarded. How unfair were they to their colleagues? I think no more unfair than their colleagues were to them. Had Chargaff been less amused, had Wilkins and Franklin been more willing to sit down to a common interpretation of the work done, etc., etc., the structure of DNA might have been found sooner. But the game was played for keeps and for high stakes, and everyone played his cards close to his chest. Yet, and this is the rub, I have a feeling that Watson and Crick were not as decent as they could have been to their colleagues. The letter to Delbrück has that ignoble (to me) request that it not be shown to Pauling; however, at worst, this is no more than the general opportunism that is the hallmark of modern competitive science. It was not a case of lifting, but rather the overtaking of step-by-step work with a strong and intuitive leap.

A third lesson in the book is that there is nothing foolish or shameful in setting out after the Nobel Prize. I have noticed that a certain "shopkeeper's" mediocrity or maturation settles on most young students. They seldom dream of conquest but rather of security and solid work. Naked ambition for a feat that wins a prize is, I think, healthier than the genteel motivation for findings that become standard reference. It is a difference in style, of course, and both poles are needed—the madman and the peasant. Still, Don Quixote, for all his wildness, is a more interesting model than Sancho Panza, even if Sancho is just as deluded.

Desinently, something ought to be said for the sensitive insensitivity of the book. It is an account of work in the context seen by the worker. As such, it is consistent and bespeaks complete candor. Watson remembers what Watson felt and writes it down. Had he spared Rosie Franklin, had he been more diplomatic, had he acknowledged the giants on whose shoulders he stood, it would have been out of character—outside his style of thinking, outside the whole nature of the man. In short, the book would have been as much a foolishness as most histories of the scientist that we have now, and as tedious. Watson is a predator, not a rumi-

nant; if he had said he lay down with the lambs and thought of God, he would have lied quite as much as if he had pretended an interest in any history he did not make.

One last comment must be made. The patronage of science works strongly against the esthetic impulse. Watson could have existed for a while as a postdoctoral fellow, but Crick would have been in serious trouble at any American university. Generally, the Establishment only pays for pedestrian advances. This has not changed from the time when Leibnitz had to develop Hanoverian history to support his philosophical and mathematical work. It is only when one takes his patrons seriously that one is lost. Watson's handling of the philanthropoids who supported him should be an inspiration to all students. Work on what's interesting—not on what the contract says.

Dr. Jerome Lettvin is Professor of Communications Physiology and a Lecturer in the Department of Humanities at the Massachusetts Institute of Technology.

ANIMAL TWILIGHT, by J. L. Cloudsley-Thompson. *Dufour Editions, $6.95; 204 pp., illus.* THE LEOPARD, by Peter Turnbull-Kemp. *Tri-Ocean Books, $12.75; 268 pp., illus.*

Books about the wildlife of Africa have been emerging from publishing houses at an ever increasing rate. They vary enormously in quality and usefulness. Some are sentimental appeals, others scientific treatises. Perhaps they all serve the common goal of arousing world interest in an endangered resource, the natural world unmodified by technological man—a world where wild things are dominant. The opportunities for saving some reasonable portion of that wild world grow less each day.

J. L. Cloudsley-Thompson has produced in *Animal Twilight* a book that deserves far more attention than it has yet received, perhaps because its glossy competitors look better on the coffee table. It is a well-balanced account of the past history and present condition of the wildlife of eastern and southern Africa, and a consideration of the job that will be required if this wildlife is to be maintained. The writer, a professor of zoology at the University of Khartoum in the Sudan, draws on his scientific training, extensive field experience in Africa, and excellent ability as a writer to produce a volume that should be read by all who are interested in Africa.

The review of historical sources about African wildlife is first-rate and

brings in many references previously unknown to this reader. The analysis of the factors contributing to the decline of African game avoids the usual pitfalls, and takes into account the adaptable nature of the animals being considered. The necessity for conservation is described in terms of economics and ecology. Conservation of Africa's wild fauna is part of the successful management of Africa's fragile ecosystems upon which man's future depends.

Peter Turnbull-Kemp's book, *The Leopard*, is in itself a vanishing species, a book about wild game by a European game ranger with extensive experience in the practical management of Africa's national parks and wildlife. It is in the tradition of J. Stevenson-Hamilton or J. A. Hunter, rather than of the modern breed of wildlife ecologists. It is perhaps significant that little of the more scientific work on African or Asian wildlife ecology is listed in the references. One looks in vain for the names of Darling or Bourlière, Talbot or Lamprey, but finds plentiful mention of Selous and Percival, Bell and Ionides.

Turnbull-Kemp admits at the start that he may tell you more about leopards than you care to know. He follows the species throughout its range, from the Caucasus to the Cape of Good Hope, from Khabarovsk to Sumatra. He covers virtually everything that can be said about the leopard; from its role in heraldry and its value as a pet, to its food habits and anatomy, with the notable exception of its ecology, which creeps in only incidentally.

This is a book designed to irritate the biologist who may be seeking specific information about some aspect of the leopard's life and times. Much of it is anecdotal, and facts come in whenever and wherever the author wants to bring them in. But then, the book wasn't written for the biologists, but for those who like to hunt, photograph, or simply contemplate the big cats. It is good reading. For this reader it brought on a great urge to go back to Rhodesia, climb a kopje, and see how the game has fared in the years that have passed.

RAYMOND F. DASMANN
The Conservation Foundation

THE ASMAT OF NEW GUINEA, by Michael Clark Rockefeller, *The Museum of Primitive Art, $30.00; 349 pp., illus.*

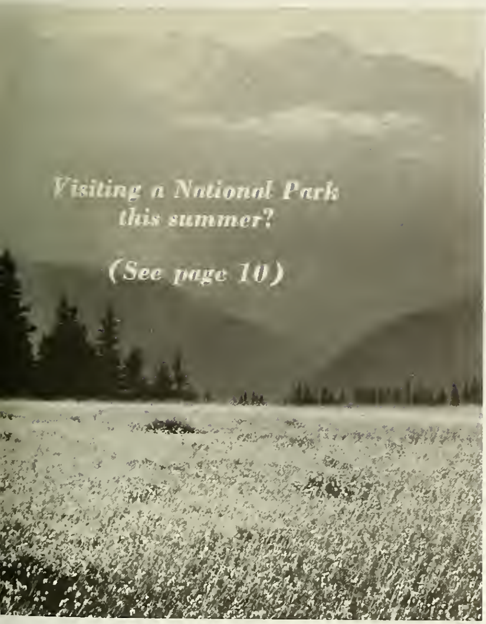
To become involved in the world about you—to participate in some way, be it small or large, in the stream of life—this is the key to the development of personality, of a whole being. For some, involvement is as natural a

Asmat tribesman, adorned with paint and feathered hairstick, peers out from porch of men's ceremonial house. Below, Michael Rockefeller talks with young boy. From "The Asmat of New Guinea."

function as eating and drinking. These are the fortunate ones among us. Michael Rockefeller was such a one.

If Richard Archbold had not discovered the Grand Valley of the Baliem in the mountainous heart of western New Guinea in 1938, it is possible that this story would have had a different setting, in a different time. In the course of events, however, Michael was invited to participate as photographer and sound technician for the 1961 Harvard expedition whose object was the study of the Ndani Tribe in the Baliem Valley. A three-week interlude in June of 1961 took Michael and a friend to the land of the Asmat people, who live in the tropical rain forest covering the great mud plain between the mountains and the sea in southwestern New Guinea. The reputation of the Asmat as wood carvers was the incentive. Writing in his journal on July 10 Michael said, "the Asmat trip wa[s] equal to most of my wildest dreams." For this gave him a brief glimpse int[o] the lives and culture of one of the stil[l] largely unspoiled "primitive" people[s] on earth. Primitive? Yes, but only i[n] the narrow context of our own egocen[-] tricity. Inspired by what he had see[n] and strongly drawn to these people[,] Michael, after rejoining his expeditio[n] and returning home for a brief visi[t] again traveled out to the country of th[e] Asmat. It was on this second trip tha[t] he met his death.

One can sense his tremendous in[-] volvement as he wrote, "I am now sur[-] rounded by my own little reality: [a] chaos of cameras and recording equip[-] ment cluttering up everything includ[-] ing my mind." But his preoccupatio[n] was not alone with physical equipmen[t]


Visiting a National Park
this summer?
(See page 10)

Associate Members of the Museum save 15% on th
five new books published by The Natural History Pr
See page 10

ıe key to my fascination with the nat is the woodcarving. The sculp-e which the people here produce is ıe of the most extraordinary work the primitive world. And as equally ıarkable as the art is the fact that culture which produces it is still ıct." Michael was a perceptive and sitive man. The impact of these peo-on him was so strong that there was self-identification and intense em-hy with them. This shines through diary pages time and again. "the nat is filled with a kind of tragedy. many of the villages have reached t point where they are beginning to ıbt the worth of their own culture l crave things western. The West ıks in terms of bringing advance l opportunity to such a place. In uality we bring a cultural bank-ıtcy which will last for many years l, what is more, poverty. Poverty er all is a relative thing." Michael v no poverty in the lives of these ɔple, only a richness and a beautiful ıptation to their land of winding ers and the omnipresent tropical ests and mud.

The material culture, which first racted Michael to the Asmat, is ıutifully presented and organized in s invaluable picture of one facet of on the largest tropical island in the rld. Adrian Gerbrands, his friend l field associate, has written an mirable essay on the history, the bitat, the art forms, and more impor-ıtly, the inner drives that lead to ɨir production. Michael's sensitive otography brings a sense of reality the words of his diary and meaning the artifacts of the Asmat, the Peo-of the Tree.

A basic principle of the Asmat phi-sophy is that death is a prerequisite life. Tragedy underlies all human e, but it should never be allowed to scure the one shining fact that life a privilege to be cherished and used the utmost. Michael used this privi-ge well.

HOBART M. VAN DEUSEN
The American Museum

ooks in Britain

by Peter Williams

"he future cannot just be allowed to happen." This phrase from a ɔok called *The Biological Time ɔmb*, neatly reflects the sense of reboding that moved the author, ritish biologist Gordon Rattray Tay-r, to produce this, his latest work. is concern is that, having seen and ıffered the challenges to the con-nued existence of humanity offered the physicists and chemists, we ill have to face the problems that the iologists are raising. In other words,

a biological time bomb has already been lit and its fuse is smoldering fiercely. We can either wait for the bang and see what happens, or set about defusing it now.

"The social consequences of what is in the pipeline," he says early in the book, "could be disastrous—nothing less than the break up of civilization." He then goes on to develop his contention, not particularly for the zoologist, the naturalist, the biologist, the anthropologist, the medical man, or any other brand of scientist, but for all these and for humanity at large. In his skillful survey of the lines along which biology is progressing, he provides naught to comfort any of us.

Rattray Taylor's argument—which he admits already sounds like a cliché—is that the biologist's ability to modify (or tamper with) man, the living organism, and the natural world he inhabits must bring in its wake terrifyingly complex problems of an ethical, emotional, financial, and legal kind. The book's strength is that he gives us so many indications of danger, from such a wide variety of biological fields, that the truth behind the cliché becomes unignorable.

For example, there is the chapter, "Is Death Necessary?" Here the author investigates the as yet fledgling but swiftly developing ideas for arresting cell death, and comes to the conclusion that these, linked with advances in implantation surgery, could allow life to be prolonged indefinitely. (There is nothing, incidentally, sensational about his account of this or any other topic; the arguments in all cases are worked out soberly, but never dully, from biological starting points that are with us now.) However, if immortality is not impossible, it would seem that the social consequences of providing it certainly are. If immortality could be applied for at the local doctor's office or purchased at the corner drugstore, then, quite obviously, the demand would be fantastic. There would be an explosive rise in population, with consequent disaster for man and his environment.

To such a dilemma, the author suggests two answers, but both bring their own problems. First, if the possibility of immortality is handed out generally, then the population problem can only be contained by putting an end to human procreation—which, as Rattray Taylor comments, is unthinkable. The practice of procreation is impelled by very strong instincts, from it the human race derives strong emotional rewards. "Indeed, the very cohesion of society may depend on the lessons learned within the child-parent relationship." And, in any case, what do we know of the sociology of a soci-

ety increasingly made up of the old in experience. old in cynicism and so on?

Second, it would. of course, be possible to make only selected people immortal. But who is going to sift the eligibles from the others, and using what criteria? The moral implications are enormous.

Rattray Taylor demonstrates brilliantly that biology can work the same sort of radical changes in a great many other areas of life: neurological intervention in the developing brain to produce a race of superintelligences in both man and animals, mind control through biochemistry, biomedical tampering to produce young from the female without direct intervention of a male and ultimately cloned human beings and animals, the widest biological control of nature for purposes of agriculture. All of these things are possible, indeed probable, and in the short term, might even be beneficial. Sooner or later, however, as with immortality, larger considerations must apply; each brings in its wake some potential danger. How then can the world be saved from such danger?

Inevitably perhaps, *The Biological Time Bomb* is at its most ineffective when it sets out to answer this particular question. Gordon Rattray Taylor is all for defusing the time bomb, and suggests that humanity must regulate the release and application of its new powers. But he is pretty vague about how this can actually be accomplished. This, I think, is understandable. After all, to hark back to the work of the physicists, we have still to work out any viable system for controlling the spread of the nuclear bomb, and we have had some twenty-odd years to mull over that one.

At the time of writing, Taylor's book is still unpublished in Britain, but it will be out by the time this column appears. I predict confidently that *The Biological Time Bomb* will closely rival *The Naked Ape* (NATURAL HISTORY, February, 1968) in the splash it makes. But whatever its success in this direction, it is clear that Rattray Taylor's message is of much wider and more immediate importance than that of the Desmond Morris book. To say flatly that the author does not effectively answer the questions he raises is to be unfair: no single man could possibly succeed. The most important thing right now is that the issues should be presented fairly, clearly, and to the widest possible public, and this *The Biological Time Bomb* accomplishes with honor.

British publishers obviously believe that today's ornithologists must be almost as handy air travelers as the birds themselves. In recent months,

they have presented the bird watchers of Britain with a tidy number of books devoted to exotic species found in very foreign parts. The areas covered include New Guinea, parts of Africa, New Zealand, and a region to which, surely, even the most well-heeled of ornithologists are unlikely to penetrate in any numbers—the Antarctic.

On the other hand, perhaps the hard-headed publishers see a burgeoning public of armchair ornithologists. Either way, they seem extremely confident that their ventures are justified.

Of the output thus far, it is the one dealing with Antarctic bird life that interests me most. And I have to admit that, excellent as it is from an ornithological point of view, this has been only partly responsible for my interest—and the interest of a great many other British readers.

The book is *Birds of the Antarctic*, and it is a splendid collection of the work of Edward Wilson, zoologist and artist. He was chief of the scientific staff on Scott's final and disastrous expedition to the South Pole, and also took part in Scott's first south polar expedition (1900-04). Wilson died with Scott on the return trip in 1912.

For me at any rate, knowing the circumstances of Wilson's death and the appalling conditions under which he had worked on both expeditions, adds a terrible beauty and pathos to his sketches and paintings. Of these, the editor, Dr. Brian Roberts, has collected almost 300; they have come mostly from the Scott Polar Institute, Cambridge, with which he is connected.

Yet leaving aside such unscientific involvements, the book still has much for the unsentimental ornithologist. The Duke of Edinburgh in his forward to another work, *The Diary of the "Discovery" Expedition*, remarked on Wilson's unique blend of "adventurous enterprise . . . meticulous approach to scientific enquiry and . . . sensitive perception." I quote his opinion here, not for tiresome British reasons of royal sycophancy, but simply because the Duke is a knowledgeable observer of bird life, and has done a great deal to push forward the cause of conservation in Britain and other parts of the world. His opinions in this field are therefore sound, and he sums up expertly the salient features of a great naturalist's character.

All these qualities are in *Birds of the Antarctic*. To start, Wilson's pictures present specimens of the area's bird life in truly the most meticulous detail, and with such sensitivity that the albatrosses and skuas, the petrels and terns, and so on, are "alive" as almost no photograph can make them. In parallel, his actual selection of spe-

cies provides a sound insight into the range and diversity of the ornithological complex.

In addition, the book contains a great deal of relevant material from Wilson's own diaries: notes on the pictures themselves, descriptions of his trips to subantarctic islands, and an account of a grueling winter trip to witness the breeding behavior of the stately Emperor penguins. This, incidentally, also produced a series of delightful drawings of the very unstately Emperor chicks. The written material is rounded out with a full bibliography of Wilson's own publications as well as those devoted to him.

Finally, something about the editor. Dr. Roberts is a leading British authority on birds of the south polar region. He now divides his time between the Scott Polar Institute and the British Foreign Office, where he is head of the Polar Region Section of the American Department. He was also one of the chief architects of the twelve-nation Antarctic Treaty, and has made full use of this diplomatic opportunity to safeguard the bird and animal life of the area. *Birds of the Antarctic* has obviously been a labor of love for Dr. Roberts, and he is to be congratulated on having carried it through so splendidly.

EDITOR'S NOTE: *Birds of the Antarctic* is published here by Humanities Press, $17.50; *The Biological Time Bomb* will be published in September by New American Library, $5.50.

Peter Williams, for five years deputy editor of the British magazine New Scientist, *is now devoting full-time to free-lance science writing.*

Briefly Noted

PLEISTOCENE EXTINCTIONS, edited by P. S. Martin and H. E. Wright, Jr. *Yale University Press, $12.50; 453 pp., illus.*

Based on the investigation conducted at the VII Congress of the International Association for Quaternary Research in 1965, this book contains eighteen papers by eminent paleobiologists, that examine the causes for the sudden extinction of large animals during the Late Pleistocene period. Mr. Martin's theories were expressed in his article, "Pleistocene Overkill," published in NATURAL HISTORY, December, 1967.

WAYSIDE & WOODLAND FUNGI, by W. P. K. Findlay. *Frederick Warne & Co., $12.95; 202 pp., illus.*

While this book is intended mainly for a British audience, it contains enough general information on the

fungi—from ecology and habitats to collection and identification—to satisfy the American reader. A good deal of discussion is given to fungi as food, and the author takes note of the large number of fatalities that occur from fungus poisoning each year. Would-be fungus eaters are advised to go into the field on a "fungus foray" conducted by an expert as the means of learning to identify the poisonous from the nonpoisonous specimens. Those who choose to play it safe will stay at home and admire the book's handsome color plates by Beatrix Potter, E. C. Large, and R. B. Davis.

ANIMALS THAT CHANGED THE WORLD, by P. D. C. Davis and A. A. Dent. *Crowell-Collier Press, $3.95; 121 pp., illus.*

This slim book traces the gradual process of domestication from its beginnings in the Middle Stone Age. The authors speculate on how, by whom, and when the domestication of animals began: most likely with the keeping of young animals as pets; by hunters who probably preceded agricultural groups; and, judging from the earliest signs, in the ninth millennium B.C. An abbreviated history of each domesticated animal takes up the greater part of the book. The entire work is adapted from *A History of Domesticated Animals* by F. E. Zeuner.

C.B.

This list details the photographer or other source of illustrations, by page.

COVER—Miriam Rothschild
6—AMNH
16—AMNH
28-33—Michael J. Harner
44—Gene Cox
46-51—Grant Heilman, except 48—AMNH after Richard Romin
52—AMNH
54-55—AMNH after Wine Institute
57—AMNH
59—Helmut Wimmer
62—A. C. Barrington Brown
68—top, Michael C. Rockefeller; bottom, Film Study Center, Peabody Museum, Harvard Univ.

Suggested Additional Reading

THE WHITE PROBLEM IN AMERICA

BLACK AND WHITE: A STUDY OF U.S. RACIAL ATTITUDES TODAY. W. Brink and L. Harris. Simon & Schuster, Inc., New York, 1967.

CUSTOM AND CONFLICT IN AFRICA. M. Gluckman. Free Press, Glencoe, 1955.

BLACK NATIONALISM: A SEARCH FOR IDENTITY IN AMERICA. E. U. Essien-Udom. Dell Publishing Co., Inc., New York, 1964.

SLAVERY: A PROBLEM IN AMERICAN INSTITUTIONAL AND INTELLECTUAL LIFE. S. M. Elkins. Grosset & Dunlap, Inc., New York, 1963.

THE SOUND OF RUSHING WATER

HISTORICAL AND ETHNOGRAPHICAL MATERIAL ON THE JIVARO INDIANS. M. W. Stirling. U.S. Bureau of American Ethnology Bulletin 117. Smithsonian Institution, Washington, D.C., 1938.

HEADHUNTERS OF THE AMAZON: SEVEN YEARS OF EXPLORATION AND ADVENTURE. F. W. Up de Graff. H. Jenkins, London, 1923.

THE HEAD-HUNTERS OF WESTERN AMAZONAS. R. Karsten. In *Commentationes Humanarum Litterarum*, Finska Vetenskaps-Societeten, Helsingfors, Vol. 7, No. 1, 1935.

HOOKED ON HISTOLOGY

THE MICROWORLD. R. Vishniac. *Boys' Life*, Vol. 56, Issue 11, November, 1966.

THE UNSEEN WORLD. R. J. Dubos. Rockefeller Institute Press, New York, 1962.

MIKROSKOPISCHE GEMÜTHS UND AUGENERGÖTZUNG. ("The Delight for the Temper and Eyes Through Microscopy"). M. F. Ledermueller. Gedruckt von C. de Launoy, Nuremberg, 1761.

FOR CLOUD WATCHERS

CLOUD PHYSICS AND CLOUD SEEDING. L. J. Battan. Anchor Books, Garden City, 1962.

CLOUD AND WEATHER ATLAS. H. D. Grant. Coward-McCann, Inc., New York, 1944.

CLOUDS, RAIN AND RAINMAKING. B. J. Mason. Cambridge University Press, New York, 1962.

THE WINE GRAPE IN AMERICA

WINE, AN INTRODUCTION FOR AMERICANS. M. A. Amerine and V. L. Singleton. University of California Press, Berkeley, 1965.

GUIDE TO CALIFORNIA WINES. J. Melville. Nourse Publishing Co., San Carlos, 1960.

Winners of Natural History's *First Annual Photographic Competition*

The prizewinners and selected honorable mentions will be placed on exhibition at The American Museum on June 25, 1968.

Grand Prize Winner

Leslie Crine
Port Jervis, New York

1st Prize for Color

Alfredo MacKenney
Guatemala, Guatemala

1st Prize for Black and White

David H. Stone
Dartmouth, N. S., Canada

Honorable Mention

Henry Schroeder
Phoenix, Arizona

Robert Gray
San Diego, California

Hugh Spangenberg
Port Jervis, New York

Robert T. O'Neal
Wilmington, Delaware

F. Holland Mills
Awendaw, South Carolina

Gary Reid
Madras, Oregon

Frank Lerner
New York, New York

Mrs. E. A. Mueller
Marfa, Texas

Denis Norton
Salt Lake City, Utah

R. L. Carlton
Ringoes, New Jersey

Joan LaRocca
Queens, New York

Donval R. Simpson
Fairbanks, Alaska

Mrs. Ella Mazel
New Rochelle, New York

Margot Granitsas
New York, New York

D. Gamble
Hay River, N. W. T., Canada

Judith Ponzi
Niagara Falls, New York

Marjorie Banas
Rumford, Maine

Dorothy Welley
Great Falls, Montana

Robert Zwickel
Miami Beach, Florida

Mrs. Lorrimer Armstrong
Westfield, New Jersey

Patricia Drew
Kensington, California

Leo LeBon
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Mrs. Ann Bartlett
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Frank Strnad
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John Edward Rowe
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Patrick Grace
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William Duesing
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Alfred Fredette
Scotland, Connecticut

F. G. Irwin
Decatur, Illinois

David H. Stone
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Richard Olen
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Keith Axelson
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Charles Noyes
New York, New York

Ruth Coleman
Brooklyn, New York

Paul Petroff
Great Neck, New York

Selwyn Powers
Bethesda, Maryland

Ed Buryn
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Robert E. Joines
Upland, California

Jack Schwab
Nashville, Tennessee

Prof. D. W. Kahn
Minneapolis, Minnesota

James Miller
Geyserville, California

Jessie Dareff
Brooklyn, New York

Benjamin Mason
Las Vegas, Nevada

Keith Gilchrist
Westport, Connecticut

Terry Broch
New York, New York

William A. Bake
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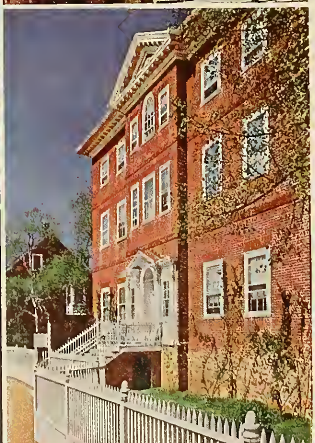

Another in Sinclair's American Conservation Series

GEORGE WASHINGTON WEPT HERE

Why the people of Annapolis fought to save their historic buildings.

The nearly unbearable struggle, the almc impossible victory, the Revolution itself w over . . . and the Leader was going home. the domed building at the left, Washingt resigned his commission. "There wasn't dry eye in the chamber", one witness wro

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THE AUTHORS


David Lowenthal


Robert J. McCauley


Sidney W. Fox


Stephanie Morgan


Joseph Wood Krutch


Margaret Mead


Rudolf Modley

David Lowenthal is a Research Associate at the American Geographical Society and Research Professor of Landscape Architecture at Harvard. He is a prolific writer and editor on conservation, geography, and history, but this article on open space is the first he has done for Natural History. Among his publications are "America as Scenery" in the *Geographical Review* and (with others) *Concepts of Conservation: a Guide to Discussion*. Dr. Lowenthal is presently making an experimental analysis of environmental perception and attitudes with a grant from Resources for the Future, Inc.

Sidney W. Fox's investigations into cellular origins and the beginnings of life have been recognized most recently by the Florida Academy of Sciences 1968 Honors Medal and Citation as Outstanding Scientist of the State, as well as by Texas Christian University's Annual Distinguished Scientist Lectureship in April of this year. Dr. Fox, who is Professor of Biochemistry and the Director of the Institute of Molecular Evolution at the University of Miami, has published several important articles on his research.

Robert J. McCauley says that the bulk of his education "has been derived directly" from his position as research assistant to Dr. Fox. Mr. McCauley has collaborated with Dr. Fox and others on articles on biochemistry. He has produced and photographed films on experimental work in abiogenesis (the origin of life from lifeless matter), including one for The American Museum.

Several years ago, says Stephanie Morgan, she was towed on waterskis very near a school of dolphins; her fascination with them finally culminated in her broad review article on these controversial mammals. She is currently studying for a Ph.D. in Anthropology at Cornell University. Miss Morgan's other fields of interest are Southeast Asian studies and ethology, and her paper on headhunters, "Background Factors of Iban Aggressive Expansion," is now in press for the *Sarawak Museum Journal*. This summer she is leaving for a year in Southeast Asia, where she will work for a time in Sarawak and prepare for formal field work.

The photographs for the essay on trees were taken by George Tice, who has been a photographer "for as long as I can remember." He has had several one-man shows in and around New York City, and is working on a book of photographs on the Pennsylvania Dutch, to be published by Doubleday.

This month Joseph Wood Krutch an acknowledged expert on desert life, has written on flash floods as a desert phenomenon. He regularly contributes to leading magazines and recently appeared in Natural History with "The Unnatural History of the Ant Lion," (March, 1968. See also this month's letters column.) Dr. Krutch has published over twenty-five books, including *Th Measure of Man* and *The Modern Temper*, and holds the Burrough Medal for Nature Writing.

Cultural anthropologist, psycholo gist, writer, lecturer, and teacher– Margaret Mead, Curator of Ethnol ogy, joined The American Museum staff in 1926. She has devoted man years to the study of the native peo ples of the Pacific, and has latel turned her attention to the study o contemporary cultures and the fur ther development of cultural theo ries of human behavior. She ha published a large body of books fo students and laymen, as well as nu merous scientific monographs an papers. Her essay. "Alternatives t War," appeared in Natural His tory's special supplement on the an thropology of war (December, 1967) Next year, Dr. Mead will becom Chairman of the Social Sciences D vision and Professor of Anthropo ogy at Fordham University's ne liberal arts college.

Born in Vienna, Rudolf Modle was an early collaborator of Ott Neurath, who developed the picto graph method of analogical commu nication. He came to the Unite States to become Curator of Soci Sciences at the Chicago Museum Science and Industry. Dr. Modley e tablished Pictorial Statistics, In and Pictograph Corporation, and co-chairman with Margaret Mead Glyphs, Inc., an organization for th development of universal graph symbols. Among other works, he ha published "How to Use Pictori Statistics" and "The Challenge Symbology."

Daniel Boone is Dead

by David Lowenthal

"Open space is like virginity," the general manager for state parks in New York City recently remarked. "Once lost, it can never be regained." But this is not entirely true of either. Only a nonvirgin can produce more virgins. And sanitary fill is a prime source of city open space, if only because the settling of decayed matter precludes building for some time. Yesterday's dump is tomorrow's park, or, to paraphrase Wallace Stegner, a man's home is his castle, but his litter belongs to everybody.

Landscape is often seen as a commentary on the human condition. And as moral metaphors, landscapes are as American as Niagara Falls and redwoods, though not so durable. To New England Puritans the primeval forest was the locus of evil, terror, and witchcraft. But in the nineteenth century, trees left the devil's domain for a higher place, and what with Arbor Day, Longfellow, Joyce Kilmer, and Smokey the Bear it is a wonder they are ever chopped down.

Moral purpose animates the design of both private and public space. A half century ago, the Department of Agriculture advocated farmstead beautification on the ground that "a home and its surroundings must be attractive in order to be most uplifting to the family, visitors, and passers-by." Urban public parks were initially intended to restore the health, improve the character, and elevate the taste of the masses. Surrounded by urban blight and squalor, public parks were places deliberately set apart—oases not only of greenery but of the behavior thought appropriate to greenery. "Foul air prompts to vice, and oxygen to virtue," was a truism of park planning in the 1890's.

Both open space and public opinion still reflect this point of view. Parks scarcely affect urban environment; they often seem pallid, woebegone substitutes for the country, rather than integral aspects of the city scene. The Secretary of Agriculture urges Americans to exchange the "rabbit warrens of the big cities for the fresh air, clean water, and space of the small towns." The latest agriculture department yearbook insists that "Man needs nature; . . . animals which are forced to live under crowded conditions develop many of the antisocial traits that fill the crime pages of big city newspapers." The Department of the Interior endorses

Nature is not to be found only in far-off, unspoiled wilderness; people care most about those aspects of the outdoors with which they are familiar

a Congressman's advice to get "beyond brick and mortar, away from the sound of cities . . . over the hills to God's own country . . . where health and happiness take root . . . where Nature quickens physical, mental and spiritual guidance."

Such pieties are regularly reiterated, but seldom documented. Some feel that evidence is unnecessary. Open space preservation "should require no defense," asserts the Open Space Action Committee. Others take refuge in the ineffable: "If the rat and the sparrow can learn to live for endless generations in the city, why cannot man?" asks Dr. Roger Revelle. Scientists are unable to give us answers, he admits, "but the prophets and poets can."

Every conference on open space "ends up waving the green flag and we salute the Sequoia," a conservation educator complains. "Having saluted the Sequoia all my life, could we not now have a good reason?" When asked whether there are psychological and biological needs for natural experience, he confessed ignorance: "I don't even know whether the question is meaningful." Meaningful or not, the Department of Agriculture still entreats Americans "to create an outdoor environment that meets the high standards of living within most of our homes," because "the outdoors, too, is our home."

Is the outdoors in fact "our home," or is it viewed, like purity, as being a rare and precious commodity which to touch is to defile? In surveys I have made, people usually associate open space with arid lands in the Southwest, great expanses and distant horizons, sweeping plains and empty deserts. Cleanness and beauty and freedom predominate, but these places are devoid of human activity. In short, they are meant for reverence, not for recreation; play would pollute them. And so, by analogy, wilderness lovers feel that use desecrates the wild. They urge its preservation as an ideal, all the more precious because rarely, if ever, experienced. "We must ask even those who love the wilderness the most," says a prominent conservationist, "to touch it but seldom, and lightly."

The outdoor activities of wilderness lovers reflect these ideals. Let me sketch a few traits of the dedicated outdoorsman, in order to point

up the implications of his behavior for recreation and the landscape.

1. *The outdoorsman observes nature mainly to count and classify.* Birds are watched to be listed; mountains are climbed to be checked off on tally sheets; hikers vie with one another in terms of miles per day and pounds per pack; the Appalachian Trail is walked from end to end as an elite achievement. This is no parody of outdoor interests; such matters are the staple of conversation on many outings.

2. *The outdoorsman is there to improve himself.* Climbs, hikes, and canoe trips are learning experiences, and instruction is continuous. Sitting around the campfire in the evening, swapping tall tales? Not a bit of it. After the tents are up, supper over, and the gear stowed away, come lessons in knot tying, fiber glassing, life preserving, and equipment buying, or educational films on the finer points of whatever the group has just done or will do next.

3. *The outdoorsman is organized.* In the name of safety everything takes place in groups; teamwork is enforced on gentle trails as on the steepest mountains. Being alone and getting lost were the height of wilderness experience for nineteenth-century visitors. Thus the painter Thomas Cole in the Catskills: *"I was lost. . . .* I felt a wild and vivid pleasure. . . . I shouted, sang, whistled, for the very horror of the thing." This is no longer fashionable. Recently I was exhorted to spare no effort in the design of a new edition of a New York area hiking guide "to prevent even one boy scout from getting lost or caught in the woods after dark."

The outdoorsman enjoys discipline whether he is dishing it out or taking it. It is customary for a group leader to berate a novice for some minor failure or infraction of the rules, and for the latter to accept it meekly; back home such a display of authority would be bitterly resented.

4. *The outdoorsman is a good citizen.* He is eager to be useful and cooperative, takes up the minimum space at campgrounds, is careful not to interfere with other campers, and leaves his site as tidy as a grave. Most other Americans still think of nature, in H. L. Mencken's phrase, "as a place to throw beer cans on Sunday." But such atavism is a source of embarrassment to the serious outdoorsman.

5. *The outdoorsman is a masochist.* His prize recollections involve being attacked by mosquitoes and black flies, drenched by downpours or by falling into rivers, frozen by icy winds or snows, and semi-crippled by extreme exhaustion. Straining muscles and fevered temples are admired as products of "clean work! clean sweat!" but as one devotee confesses (or boasts), "few but the hiker will understand this reverence for exertion." A canoeist put it more baldly, describing portaging as "quite simple: just equal parts of masochism and brute force." And although paddling a heavily loaded canoe "is not exactly the same thing as being a galley slave, it does afford some insight into what that life was like." Thoroughgoing outdoorsmen even make a fetish of hunger. We are enjoined to emulate Thoreau, who "boiled a handful of rock tripe . . . for more than an hour," and happily announced that "it produced a black puff . . . not positively disagreeable to the palate."

Discomforts are praiseworthy because they promote intimacy with nature; they also dissuade the tender and unconverted from putting in an appearance. Those who avoid discomfort are dismissed with derision or contempt. Neither age nor condition is an adequate excuse for refusing to suffer. When one outdoorsman noted for his ability to take a beating finally, in his sixties, bought a VW camper, his former cronies shook their heads over this mark of weakness, and the rumor went around that the poor man had slipped so far from the true path as to spend an occasional night in a *motel.*

Outdoorsmen who endure allow themselves only the most meager comforts and rewards. Novice climbers at the Appalachian Mountain Club winter training school are enticed to the summit by the promise of a lemon and a bite of "glorp"—pressed bar of raisins, nuts, cereal and chocolate. The shivering canoeist scathed by a river mishap is surreptitiously offered the smallest nip of whiskey to warm him.

I do not mean to traduce the experience or impugn the motives of the outdoorsman. His ascetic traits notwithstanding, he must still be viewed as a recreation seeker, in th

sense of Marion Clawson's definition of "recreation" as activity undertaken because one wants to do it. Nevertheless, his quest for purity and virtue in the outdoors is sharply at odds with the recreation demands and behavior of the great majority.

The general public views the outdoorsman as commendable, but seldom worth emulating. "The urge to 'get back to nature' is an important factor in the lives of increasing numbers of people," the U.S. Forest Service claims, but its picture of what people do is sharply at variance with this statement. Most campers today are in a hurry; they have a lot to see and a schedule to meet. Equipment and facilities are increasingly luxurious. People with mobile trailers want electrical and water hook-ups rather than fireplaces and tables; they insist on hot and cold running water, showers, flush toilets, and laundry facilities. Indeed, the Forest Service concludes, "visitors seem to be increasingly 'soft.' They don't venture far from their cars. Life in camp, in terms of creature comfort, is not much different from that at home. . . . Even hunters are tending to use motels and restaurants as a base of operations instead of the traditional hunting camp." People may like a taste of the outdoors, but they usually do not want to live in it, however briefly. Their campsites often look as unlike the outdoors as possible.

Above all, most Americans are gregarious. Solitude and silent communion with the great outdoors are the last things the average camper seeks. "My notion of camping," writes Faith McNulty, "was that we'd . . . manfully make our little home in the wilderness, enjoying the slightly scary pleasures of solitude and independence." But finding no remote spots, they "camped where Americans are supposed to camp"—in state and national parks. "These camps are about as sylvan as Central Park. . . . The whole place was as busy and as merry as the zoo on Sunday. . . . When I mentioned the idea of solitary camping to any of our campmates, they looked puzzled or dismayed. 'You mean you want to camp where there's nobody *around*?' a woman in Zion Park, Utah, asked, in horror. 'Why, I'd be scared simply stiff!' "

The traffic jams at popular national parks are deplored by nature lovers, but the ordinary tourist wel-

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comes the presence of his fellows as a cheery reminder that he is not alone in the wilderness. At the Grand Canyon not one visitor in a hundred ventures below the canyon rim. Few leave well-worn paths. In Yosemite Valley, Fourth-of-July campers are estimated at more than eight thousand per square mile: "The damp night air, heavy with a pall of eye-watering smoke, is cut by the blare of transistor radios, the clatter of pots and pans, the roar of a motorcycle, and the squeals of teenagers." Except for the trailers and tents "this might be any city after dark."

But this is essentially how people like parks. Indeed, it is close to what was anticipated by the proponents of our first national park. When N. P. Langford admired Yellowstone Lake in 1870, he predicted it would soon "be adorned with villas and the ornaments of civilized life. . . . The march of civil improvement will reclaim this delightful solitude, and garnish it with all the attractions of cultivated taste and refinement."

Daniel Boone is reputed to have felt crowded when he saw the smoke from another cabin. Daniel Boone is dead. Most modern campers do not object to pitching their tents a few feet apart: a campground is said to be full only when you have to use the other fellow's tent pegs. Recreation specialists have conscious or unconscious standards of use intensity which most folk are willing, even happy, to exceed. After Labor Day, when most campers leave Yosemite, the rest huddle together to maintain a comfortable feeling of density.

Most Americans enjoy nature not to "get away from it all" in the wilderness, but to relax in familiar surroundings. The laundromat at Mesa Verde National Park made a lady from Kansas "feel right at home, they even have my favorite detergent." Modern camping is "the definitive means of getting close to nature . . . without coming to grips with it," according to Gilbert Millstein. "Nobody chews pemmican or gnaws on edible roots and only a handful of eccentrics . . . invite their souls on a bed of boughs." The campers at Groton State Forest, Vermont, all had portable refrigerators and were given stacks of firewood (from logs cut outside the forest). Millstein concluded that their pioneering drive was "a return to the soil—in the fashion . . . of

Continued on page 64


THE LIVING RACES OF MAN
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A Naturalist at Large

Crowded Animals

by Marston Bates

Biologists have been interested in the study of animal populations ever since the day when Thomas Robert Malthus first enunciated his "dismal theorem." As stated in the 1803 edition of his *Essay on Population*, the Malthusian propositions are: first, that "population is necessarily limited by the means of subsistence"; and second, that "population invariably increases where the means of subsistence increase unless prevented by some very powerful and obvious checks." In the case of man, Malthus considered that the checks were all resolvable into "moral restraint, vice and misery."

Malthus was concerned with the human problem, and human populations certainly often behave in accord with the Malthusian propositions. If one used "moral restraint" to cover contraception, abortion, infanticide, and continence, one could well argue that they always apply. And if Paul Ehrlich is right in his article on "The Coming Famine" in the May NATURAL HISTORY, we are all in for a great deal of misery presently because of man's continuing multiplication—and I am afraid that he is right.

But what about other animals? Undeniably the means of subsistence is the ultimate limit on any population, but in natural communities animals rarely live up to this limit. There usually seems to be plenty of food for all, and death through starvation is probably rare. As a graduate student, I specialized in the study of our native fruit flies (Trypetidae), and I became impressed with the quantity of wild fruits I had to examine to find a few larvae. Most of this perfectly good fruit-fly food was going to waste! Now I look out the window at the trees, shrubs, and grass and think about all the caterpillar fodder that is not being used—even in a situation where no insecticides have been applied.

Where a population does live up to the limit of the means of subsistence, catastrophe is likely to result. The incredible hordes of migratory locusts, which at times strip the countryside of every green thing in various parts of the world, are a case in point. Locust plagues have been recorded in Egypt and Assyria since the beginning of written history. Disastrous insect outbreaks are often the consequence of man's interference with the ordinary balance of natural communities, but this can hardly be the case with locusts. There is even what might be called a "fossil" locust swarm, which became embedded in the ice of the glacier on Mount Cook in Montana in pre-Columbian times. Because of the damage they cause, these insects have received a great deal of attention from entomologists, but there was no explanation of the swarming migratory flights until 1921, when B. P. Uvarov first announced his phase theory.

The migratory locust of the Near East had been classified as a species (*Locusta migratoria*) distinct from a similar solitary grasshopper (*Locusta danica*). The two differed in measurements of head length and width, leg length, and color (*migratoria* being dark and *danica* green), as well as in behavior. Uvarov found that if hoppers were raised under crowded conditions, the adults turned into the migratory form; if they were raised in isolation, the adults were of the solitary form. The two "species" were different phases of the same animal.

Uvarov's theory has been amply confirmed by subsequent work—it has the status of a fact rather than a theory. All of the seven grasshopper species in different parts of the world

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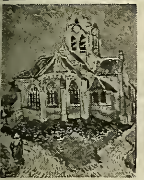

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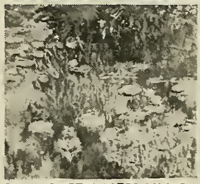

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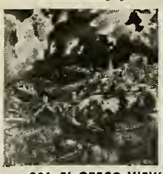

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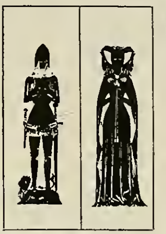

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that sometimes form dangerous locust plagues have been found to show this phase phenomenon. The solitary forms live dispersed in grasslands, slowly building up in abundance until, at some stage in crowding, the restless, gregarious migratory form appears and the great hordes of insects, darkening the sky, take off to devastate any vegetation in their paths. The swarms may fly out to sea, and they almost always end in some environment where the species cannot survive. New swarms are then built up from individuals that stayed behind in the homeland.

The mass suicide clearly serves as a final limit to population growth. But what adaptive value does this behavior have that could lead to the evolution of the two different phases? The most widely held theory is that the migrations are a form of "environment hopping." The grasshopper species that occasionally form migratory swarms live in arid or semiarid regions where the environment is never stable for long. The phase change provides a way in which the species can occasionally burst out from one kind of habitat into others. It gives the species two ways of life instead of leaving it chained to one—another case of the value of diversity. Most swarms die out, but sometimes populations may become established in new areas, thus promoting the survival and dispersal of the species.

It has recently been found that a number of other kinds of insects show phase changes when raised under crowded conditions. At first it seemed that this might be the explanation of other insect migrations —and the phenomenon does hold true in many cases. Unfortunately, some non-migratory species, such as the European Emperor moth (*Saturnia pavonia*), which does not even have functional mouthparts as an adult, also show dark phase changes when raised under crowded conditions. There is no one-to-one relation between phase change and gregarious migration in all insects.

A number of species of Lepidoptera, especially in the tropics, show mass gregarious movements that seem to be suicidal. I have stood on the Caribbean coast of Honduras and watched millions of butterflies, several species flying together, streaming out to sea and certain death. Little is known about the background of these mass swarms: the species are of no economic importance, and the population buildups occur in remote parts of the tropics where there are no entomologists to study them.

The mass suicide of these insects brings to mind the famous case of the Norwegian lemmings. Lemmings are small, mouselike rodents that inhabit the subarctic regions of both hemispheres. Most species show rather regular cycles of abundance with peaks at intervals of three or four years. This has been the subject of a great deal of study—Charles Elton wrote a book about it, with the title *Mice, Voles and Lemmings* —but we still can hardly be said to understand the cyclic regularity. The Norwegian lemmings have attracted particular attention because in years of abundance they pour down from the mountains toward the sea through farms, villages, and towns—indifferent to all obstacles.

G. C. Clough has written a first-hand account of a lemming outbreak in Norway, entitled "Lemmings and Population Problems," in the June, 1965, issue of the *American Scientist*. "The peak population, which I watched all through the summer," he writes, "began to move downward from the alpine shrub and lichen zones rather suddenly in mid-July. During the short night and early morning hours, I could see individual animals proceeding at a steady pace down along a hiking trail. While I sat at a convenient observation point where a road crossed a small river, as many as forty lemmings per hour passed by. These animals were not heading toward a good wintering ground. In fact, by September and October, when the first snows came, many of them had settled in the large, low-lying marsh and in a hayfield devoid of green grass. None of them survived the winter here. Other wandering lemmings began to appear at the nearest town and surrounding pine forests twelve miles away down the valley."

The migrating lemmings were completely antisocial. Whenever one animal encountered another, there would be antagonistic squeaks and posturings, even boxing with the forefeet. But in the wild, Clough never observed actual biting. If, however, he placed two lemmings together in a small cage, they would fight savagely until one of them died, always within twenty-four hours.

There have been many laboratory studies of the effect of crowding on animals. Overcrowding results in a slowed rate of growth and in undersized, weak adults—easily enough explained in terms of food shortage. But even when provision is made so that an abundance of food is always available, there may be striking changes in behavior and physiology. Most of the studies have been made with rodents, and in these animals the overstimulation under crowded conditions results in a disruption of the usual endocrine balance, causing, most notably, an enlargement of the adrenal cortex. The consequences are diminished reproductive functioning in both males and females, inhibition of growth, increased susceptibility to disease, and so forth. The endocrine changes under caged conditions are clear; whether comparable changes occur under crowded conditions in the wild is not so well established, although it would seem a likely explanation of abnormal behavior.

Interestingly enough, it has recently been discovered that hormone changes are associated with the shift from solitary to migratory phase in locusts. The glands concerned are very different, of course, from the endocrine glands of mammals, but the principle of chemical control over behavior may well be the same.

Probably the best-known studies of the behavior of mammal populations under confinement are those carried out by John Calhoun with the Norway rat. He has published many papers on these studies, but perhaps the most convenient summary is that given in the February, 1962, issue of *Scientific American*, entitled "Population Density and Social Pathology."

Calhoun has observed his rats in Baltimore back yards, in large outdoor enclosures, and in carefully designed laboratory cages. He has tried to make caged conditions as "natural" as possible by using large enclosures provided with nest boxes, hiding places, runways and the like. There always remains, however, the problem of evaluating the behavior of animals kept in enclosures: immigration and emigration are ruled out; one animal chased by another cannot flee from the experiment. Observations made under experimental

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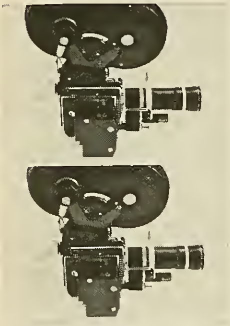

conditions must always be checked with studies in the field if they are to be correctly interpreted. Fighting behavior in particular is apt to be exaggerated under caged conditions—witness the difference between wild and caged lemmings observed by Garrett Clough. On the other hand, it is often difficult to understand behavior in the wild without testing animals under controlled conditions. Calhoun is certainly aware of all of this, yet his work has been criticized as not making sufficient allowance for the effects of restricted space.

In general, Calhoun and others have found that under crowded conditions, but with ample food available, behavioral changes occur that greatly reduce reproduction. The most striking cases involve the formation of what Calhoun has called "behavioral sinks." In experiments in which a large enclosure is subdivided into pens with restricted access, dominant males may establish more or less normal reproductive relations in some pens, while the other pens will be occupied by the outcasts, who show various abnormal behavioral patterns—who show "social pathology."

Females in a behavioral sink become sloppy nest builders or fail to make nests at all; litters are aborted or young neglected, making for a high infant mortality. Some males become extremely phlegmatic, losing all interest in sex or in fighting. Others become hyperactive—the "probers"—attempting to mate with other males or with females not in estrus, showing what Calhoun has called "pansexual behavior." They also tend to be cannibalistic, eating the abandoned young.

Thus the "vice and misery" of the Malthusian propositions develop in rat populations as well as in human. Whether rats in nature form behavorial sinks is a matter of debate; the lemmings at least show that odd behavior may be the consequence of crowding in the wild. Inevitably one compares rats in a behavioral sink with humans in a crowded ghetto. Certainly people often behave very much like rats—as Konrad Lorenz has pointed out in his book *On Aggression*—but I think the differences outweigh the similarities. We may, however, be able to learn something about ourselves by studying rats.

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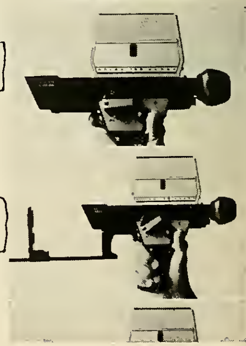

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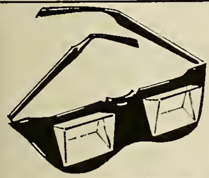

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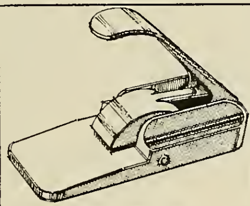

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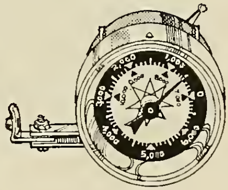

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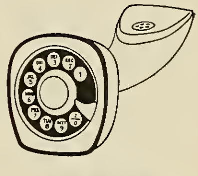

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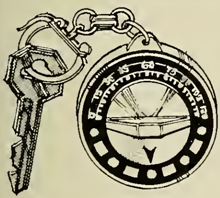

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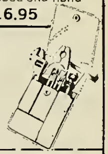

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Could Life Originate Now?

by S. W. Fox and R. J. McCauley

Records tell us that belief in abiogenesis—that life can originate naturally from lifeless matter—dates back at least as far as about 700 B.C. For many centuries thereafter it was an integral part of most philosophical and scientific thinking. But in the eighteenth and nineteenth centuries came a drastic change, and history books continue to tell us that in the 1860's Louis Pasteur proved conclusively that belief in spontaneous generation of living organisms was not valid. The French chemist set up his elegant experiments much more rigorously than did any of his contemporaries or predecessors; the inferences from his results were accepted as the final blow to the concept of abiogenesis.

Since Pasteur's time, investigators have amassed a huge catalogue of widely differing forms of life and of processes going on within life's basic functional unit, the living cell. It is understandable that this profusion of variations and intricacies has reinforced the conclusions drawn from Pasteur's experiments over a century ago. In its advance, the study of life processes has become so staggeringly complex—biochemically, genetically, cytologically—that many have accepted a negative premise. In their view, life is much too intricate and subtle; man cannot even begin to guess how living systems might have come from nonbiological matter. In other words, it has become comfortable to think that life today is too complicated, and was already too complicated in early geological times, to organize spontaneously.

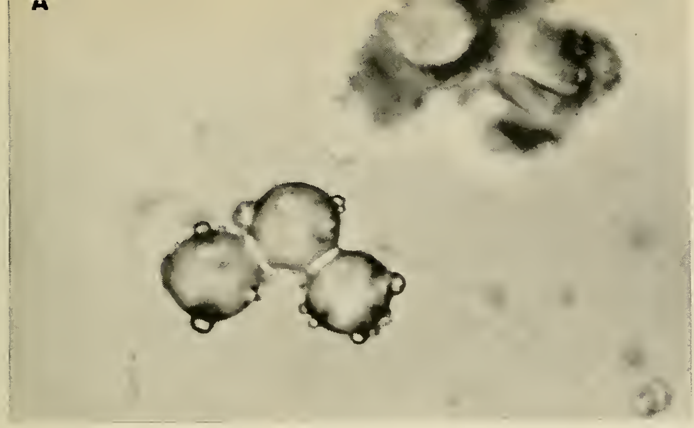
However, some others have not been overawed by the intricacies of the living cell. They have reasoned that all this complexity involving enzymes, the nucleic acids DNA and RNA, cellular structure, and organelles betokens a very advanced or specialized stage, which would have been unnecessary at the beginning of evolution of organisms. Furthermore, they doubt that a so-called vital force was necessary to change non-living matter into living matter. They feel that the phenomena of chemistry and physics would have been sufficient. From experimental observations they have found increasing evidence for the powers of self-assembly. Here is an avenue by which a simple version of a living system can result spontaneously after smaller molecules organize into macromolecules.

To understand the basis for this newer attitude let us avoid futile attempts to define life. Until more facts become available, no scientists, except a few who may be dogmatically inclined, care to argue over a definition of life. Consequently, this article is limited largely to evidence of systems that assemble themselves and have many of the properties of contemporary life.

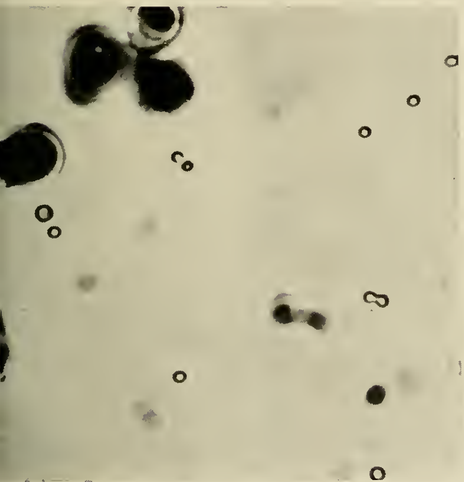
Let us start with a premise and a method. The premise is easy to accept: Life must have arisen at least once in the past. The method is to find out what conditions and materials on earth would have originally been necessary to yield a living unit or the prototype leading to it. This leads to the main question considered here: Can life begin now? To answer it in a disciplined way we can turn to recent experimental evidence from the laboratory on how life may arise, or might have arisen, abiogenetically. We can then assess the probability of such processes occurring naturally in today's environments.

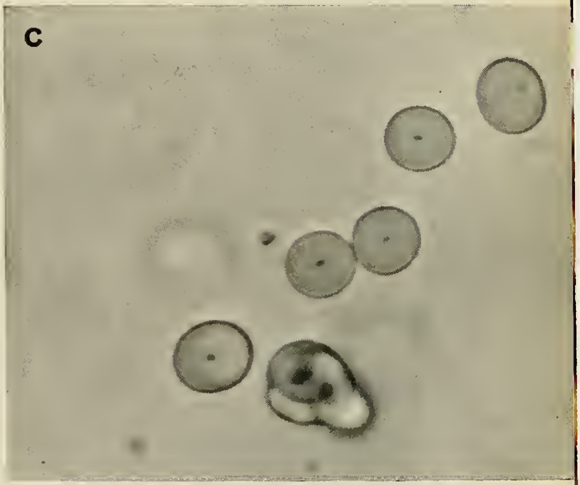
For the foundation of such research we must look back a few decades. Following Pasteur's experiments, the disbelief in abiogenesis was not penetrated by an important shaft of light until 1924. In that year the Russian biochemist A. I. Oparin published his boldly titled book *The Origin of Life*.

Oparin hypothesized that the first occurrence of life on earth was preceded by the formation of various organic compounds; that they came from the simpler kinds of material a primitive atmosphere might have provided—from clouds of water vapor, methane, ammonia, and hydrogen (the most abundant element in the universe). This concept of a molecular evolution served as a point of departure for the newer thinking on spontaneous generation. Chemists have confirmed Oparin's thesis that simple gases can serve for synthesizing a wide variety of simple organic molecules common to living things. Also verified is the presence of such reactant gases not only in our prebiological past here on earth but on neighboring planets today.

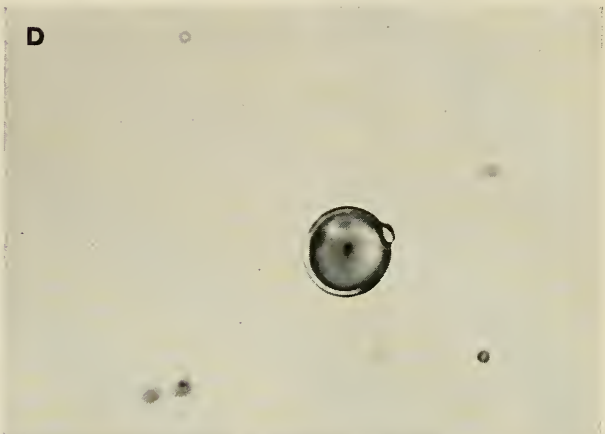


Laboratory version of a path to life: (A) these spheres (1,500 X), self-formed from protein-like molecules derivable from simple gases, now begin a kind of budding; (B) the buds can be freed from parent spheres by thermal shock; (C) by accretion, buds grow into microspheres; (D) new sphere proceeds to develop a second-generation bud.





The current concept of abiogenesis starts with those gases and the five elements they contain: carbon, nitrogen, hydrogen, oxygen, and sometimes sulphur. We know that in the laboratory the gases can be converted into amino acids and in turn these fairly simple organic compounds serve as building blocks for large molecules, both in the laboratory and in nature. Nature commonly constructs many vital compounds, including the enzymes and other proteins essential to life, by linking amino acids of various types into large chainlike molecules called macromolecules. This is the kind of assembling procedure that the genetic molecule DNA directs in contemporary organisms.



But need life have originated only after evolution had already reached the point of producing nucleic acid, which then would govern the joining together of amino acids to produce enzymes, more nucleic acids, and the like? A simpler way has received more attention from those of us at the University of Miami's Institute of Molecular Evolution. It gives a consistent explanation for how the first primitive forms of life could have arisen.

Like other concepts, this approach begins with synthesizing simple compounds from the earth's primordial gases. In line with Oparin's ideas, the first experiments produced very simple organic compounds from inorganic materials. Fifteen years ago, S. L. Miller, then of the University of Chicago, reported synthesizing four of the amino acids commonly found as building blocks in proteins. Miller used the gases that Oparin reasoned would have been in the earth's primitive atmosphere. For the energy needed he passed electrical sparks through them, and found he had produced alanine, glycine, aspartic acid, and glutamic acid.

In following years, scientists in several research centers around the world showed they could synthesize several more of the protein-related amino acids by trying various combinations of primordial gases and types of energy—not only the gases Oparin proposed, but also hydrogen cyanide, hydrogen sulphide, carbon monoxide, and carbon dioxide; not only by an electrical discharge but by ultraviolet radiation, ionizing radiation, visible light, and heat.

One of the most comprehensive of these syntheses was reported in 1964 by Harada and a coauthor of this article (Fox) working at Florida State University. Utilizing heat energy with silica as a catalyst, we showed that most of the eighteen protein-forming amino acids could be produced from three substances—methane, ammonia, and water. The absence of hydrogen as a reactant permitted the formation of such hydrogen-poor amino acids as tyrosine and phenylalanine.

In producing many of the proteinaceous amino acids, research had come a considerable distance. Yet it had moved very little closer to a penetrating understanding of how life began. A formidable barrier to scientific understanding had not been eliminated; rather, an inherent prejudice against simple beginnings had been exposed. What could happen with those synthesized amino acids? Might something much closer to life arise—might the amino acids lead to synthetic protein-like molecules?

The method used to answer this question at our laboratory was disarmingly simple. We heated a mixture of the various proteinaceous amino acids to a temperature above the boiling point of water. Thereby the relatively small amino acid molecules combined to form protein-like macromolecules. These polymers we called proteinoids because their building blocks were amino acids and their size was comparable to that of small protein molecules.

Our understanding of proteins and proteinoids is extensive but incomplete. Nevertheless, both categories share a long list of properties and are importantly alike in the quantitative and qualitative composition of their constituent amino acids; the identifying presence of characteristic peptide bonds that hold amino acids together; the high molecular weight of the macromolecules; the generally similar response to a wide variety of common tests for protein.

Though not identical to contemporary proteins, proteinoids have enough protein properties to allow us to visualize easily their evolving to contemporary proteins. Accordingly, they and their properties may answer the basic chicken-and-egg question: How could enzymes and other proteins have arisen without enzymes already present to produce them? Molecular evolution from proteinoids could be the answer, thereby solving one of the most fundamental problems confronting a theory of abiogenesis.

It is especially interesting that six laboratories have found the synthetic compounds work like natural enzymes (which are proteins, of course) in catalyzing the reactions of natural substances. As with enzymes, the kind of catalytic work done varies with the kind of proteinoid. Each can do at least several jobs.

Over-all, the formation of proteinoid is significant in that the reaction requires no nucleic acid or other such architect to supply a blueprint. Under conditions known to be widespread on the contemporary earth and inferable as having been even more widespread on the primitive earth, the various synthetic constituents fall into a self-selected sequence during synthesis of the polymer.

Now the next step. The internally self-ordered macromolecules can assemble themselves into microspherical units remindful of the living cell. The discovery of this capacity was especially responsible for encouraging the belief that we can reach meaningful answers to our questions about the origin of life.

Conditions required for self-assembly are as simple as making instant coffee—only the addition of "water" is required. As with instant coffee, the process yields a better "flavor" if the water is first warmed. The experiment can be performed either with water and purified proteinoid, or simply water and a hot polymer reaction mixture still in the crude state, much as we visualize it would be in a terrestrial locale. When the resultant suspension is cooled and examined under a microscope, one can see literally millions of small, spherical, cell-like units, which we have called microspheres. They are typically from one to three microns in diameter; a string of 25,000 would measure about one to three inches long. One can quickly see gross morphological similarities between these microspheres and various natural living forms, especially in comparison with coccoid bacteria, which are about the same shape and size.

In the past ten years we have carried on an unending series of experiments with microspheres. This work, aided by the electron microscope, has uncovered a wide variety of structural and dynamic complexities characteristic of the microspheres and has shown an array of self-organizing properties. We have also noted marked similarity between sections of microspheres and of the simple microbe, *Bacillus cereus*, after both were prepared by the same procedure.

Closer examination of the boundary around the microsphere, again

with help from the electron microscope, revealed its double-layered structure—this quickly reminds us of the layered configuration of biological membranes. Furthermore, experimental evidence disclosed that this visual similarity is more than structural. Osmotic activity can be demonstrated in the microsphere, as in living cells. We have shown that the microsphere boundary has the selective ability to retain large polysaccharide molecules and let small monosaccharide ones go through.

Next comes the question of self-replication—of like reproducing like. We are familiar with the chromosomic process, called division, by which living cells reproduce. We do not expect this from microspheres, which lack nucleic acid, but do they show something that accomplishes much the same result?

Many cells reproduce by binary fission. However, some yeasts and bacteria reproduce by budding. After noticing that microspheres also form buds, we began a rigorous investigation. Observations showed that when the microspheres had aged a week or so in their mother liquor they go through the first stage of what is a simple replicative cycle of budding. The buds that result can be removed by mechanical, thermal, or electrical shock, and the liberated buds can be made to grow larger by a process of accretion. This simply requires seeding them into a new proteinoid solution saturated at a slightly higher temperature. When the solution cools, proteinoid material deposits upon the buds. These new microspheres reach normal size, and when aged as before, they display buds—this time of the second generation.

This procedure differs in some ways from the more complex technique characteristic of contemporary budding in the yeasts and bacteria. However, it carries out the essential function of a reproductive process. And it does so without nucleic acid. Information is transferred from the amino acids to polymer, and from environment to individual without great change.

The experiment illustrates a new direction that chemistry and physics are taking: away from old-fashioned vitalistic notions; towards systems chemistry and the physics of interacting systems. In this biological context, the causes for such phenomena as budding and growth must ultimately be traced back to the molecular level, but the actual budding and growth result from interaction of systems.

With the newer view and the kind of reproductive process just described, we can visualize how the traditional forces of Darwinian selection could have begun to develop greater sophistication and more ramifications: and how if such selection went on long enough, the spontaneous sequence of steps might ultimately have reached the high levels of organization in living forms today.

To illustrate how simply the steps could have occurred, we can start with the 18 amino acids common to protein, mix these dry materials, and place the mixture on the surface of a preheated chunk of lava in the open air of our laboratory. We can use any amount of each amino acid over a wide range of proportions.

The hot lava corresponds to any thermal zone of sufficient temperature on the earth's primordial surface. When the amino acids touch the rock they begin melting and releasing water vapor. This indicates a reaction that is producing peptide linkages between the amino acids, with water as a by-product. Within a few minutes the amino acids have finished melting and polymerizing to form proteinoid, a viscous, amber-colored, glassy substance. Within twenty minutes we terminate the reaction with a drenching rainfall of water from above. Again this mimics what must have happened often in primordial times billions of years ago. When we now examine the run-off water under a microscope we find normally formed microspheres, with their characteristic boundaries.

Hardly any experiment could be simpler. This one dramatically emphasizes the real possibility that primitive life could rapidly and often organize spontaneously from readily formed materials of an appropriate kind. These are cell-like units from a material like protein, a material that in turn arose from amino acids formed from such materials as methane, ammonia, and water vapor. Here, man initiated the combination of conditions and materials. We cannot doubt that nature could have easily done the same.

Meanwhile, in our laboratory and in others, experiments are being actively conducted on the formation of other small biomolecules from non-biological materials. Experiments have demonstrated the formation of vital subunits of nucleic acid: the purines—adenine, guanine, xanthine; and the pyrimidines—uracil and cytosine. Ribose and deoxyribose, equally important constituent subunits of RNA and DNA, have been produced. Likewise, synthetic methods have produced the energy-rich sugar glucose-6-phosphate. By combining the nucleic acid bases, sugars, and phosphates, experimenters have demonstrated the formation of nucleotides—the primary building blocks of nucleic acids. Small polymers of the mononucleotides have also been produced. Though these polynucleotides resemble nucleic acids considerably less than proteinoids resemble proteins, they may be a doorway to further research. Such synthesis from primitive materials could go a long way toward satisfying the molecular requirements of most contemporary biotic forms that depend upon DNA and RNA.

Meanwhile, the experiments stressed here show that a sufficiently high level of complexity can easily be achieved from amino acids, without the need of guidance from genes. Accordingly, we seriously doubt the need of prescribing nucleic acids as necessary for primitive or simple living things. In this way, also, we may be coming closer to a series of definitions of life at different stages.

Some incomplete evidence now suggests that at least one contemporary replicating unit can thrive without nucleic acid. This is the pathogen called scrapie, a disease found in sheep. Investigators have suggested that the troublemaker is a self-reproducing protein entity. Unlike more conventional diseases, this one does not stimulate the formation of antibodies. Although evidence for its protein nature is still not complete, the evidence indicating the absence of nucleic acid is considerable.

Also without need for nucleic acids are the relatively simple processes that turn amino acids into self-

replicating microspheres. From this we reason that more complex forms could have evolved later, although that possibility does not rule out other primordial sequences.

Is the environment still able to foster the amino acid process we have been describing? Upon what could abiogenesis draw today?

Raw materials present no problem. Experiments confirm that some of the necessary kinds would be available for producing amino acids. What about the energies needed for such spontaneous organic chemistry? A survey shows that all the kinds of energy used in key contemporary research are available from our environment today. The same energies are believed to have existed in primordial times. Electrical discharge in the form of lightning is found in most regions of our planet. Solar energy is available now much as it was in the past. Thermal energy—heat—is abundant on our planet and could be relied on to energize a wide variety of reactions identical to those being carried out in the laboratories.

Furthermore, the amounts available need not be the deciding factor. The quality of the energy may be much more significant, perhaps even crucial. In nature, for example, moist proteins are not stable under high-energy radiation, but the same sensitive molecules can tolerate heat over quite a moderately wide range of dry conditions.

As for proteinoid microspheres, one kind of information about the conditions needed for their spontaneous origin comes from comparing them with microfossils found on earth and with "organized elements" found in meteorites. One explanation for the similarities observed is as follows: the meteorite and the microfossils do not represent once-living forms but, rather, forms that were not quite alive. And if the fossils do date back to a time before living cells had evolved, they are all the more significant.

This explanation has plausibility because laboratory conditions that produce the microspheres resemble conditions that existed in meteorites and in our earth's early strata.

In any event, the search continues for facts about the similarities and differences between "organized elements," microfossils, and microparticles formed from amino acid polymers. These comparisons relate directly to the search for extraterrestrial life. They indicate that the older approach—interpreting results of simple tests performed by remote control and monitored on earth—is unreliable. Those tests can hardly be expected to confirm the existence of life on celestial bodies.

Laboratory experiments tell us, even more than the theory of biological evolution has been able to do, that the pathway of evolution is tightly controlled internally. A variety of local environments would increase the likelihood that the internally directed self-organizing process would occur. The meaningful questions concern, not the average chemistry of a planet like Venus, but rather, what is the variety and nature of local conditions? For instance, it seems more reasonable that the early stages of molecular evolution did occur on the moon at one time. This increased probability comes from our learning recently that the moon has a basaltic crust like that of the earth. This means its geochemical history probably did resemble this planet's history enough to include the presence of water.

We now return to the main question with which this article began: Can life begin now? It has already been answered with a more or less qualified affirmative by Darwin, Oparin, Keosian (Rutgers), and Fox.

A qualified "yes" poses a logical corollary question: Then why do we not see life beginning now? Darwin proposed that all of the conditions that ever could have been present for abiogenesis still exist on earth. However, in a letter to a friend he went on: "But if (and oh! what a big if!) we could conceive in some warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, etc., present, that a protein compound was chemically formed ready to undergo still more complex changes, at the present day such matter would be instantly devoured or absorbed, which would not have been the case before living creatures were formed."

Keosian, author of a much used textbook on the origin of life, had a similar view: "No newly arising form can withstand the competition against already adapted forms in the fierce struggle for existence."

Oparin also saw such obstacles, but was less pessimistic. He focused on possibilities of a less immediate threat to the safety of the newly formed organism. He believed that *de novo* synthesis was possible on some extraterrestrial body. He also proposed that life could be originating right now in "some out of the way parts of our planet."

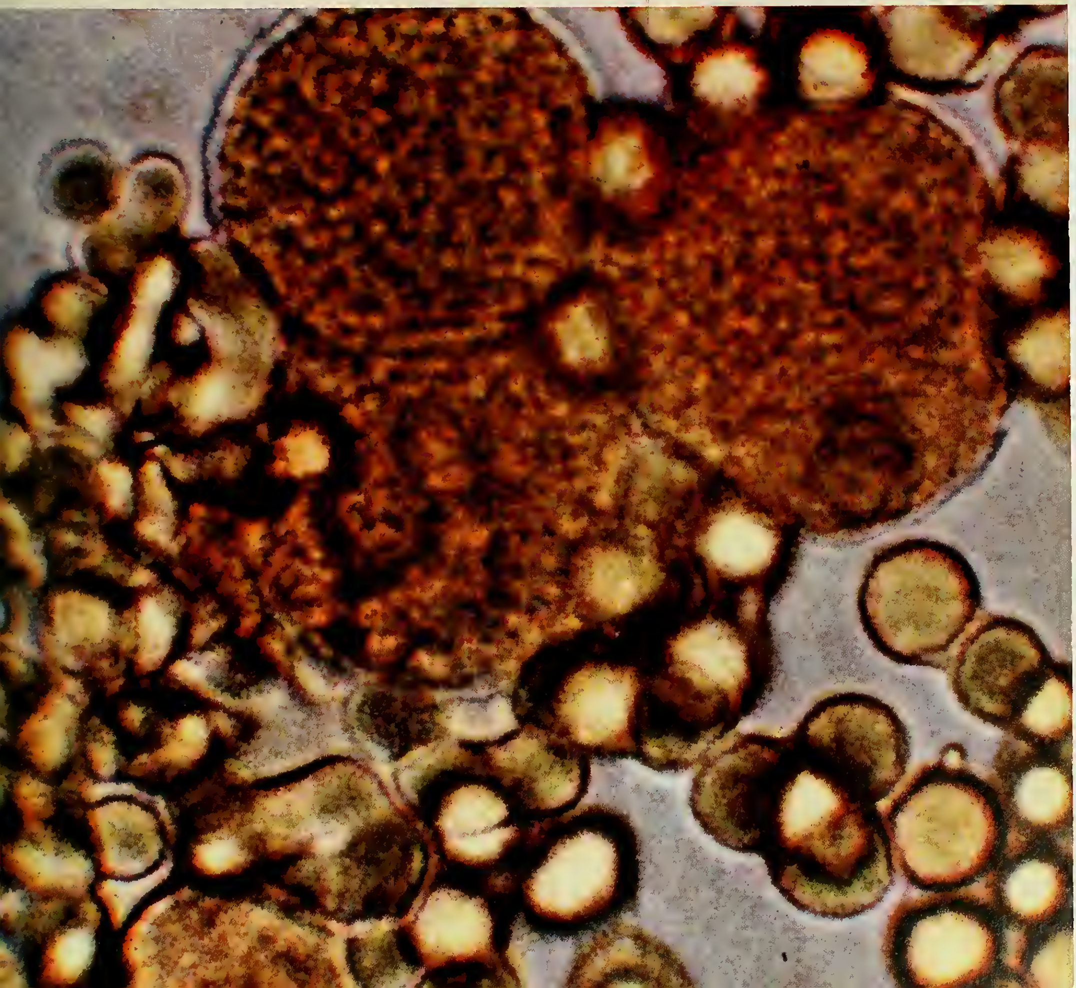
If Oparin's suggestion is true, why has such life not come to our attention? The answer suggested by Fox is based on the increasing evidence that evolution is self-limiting.

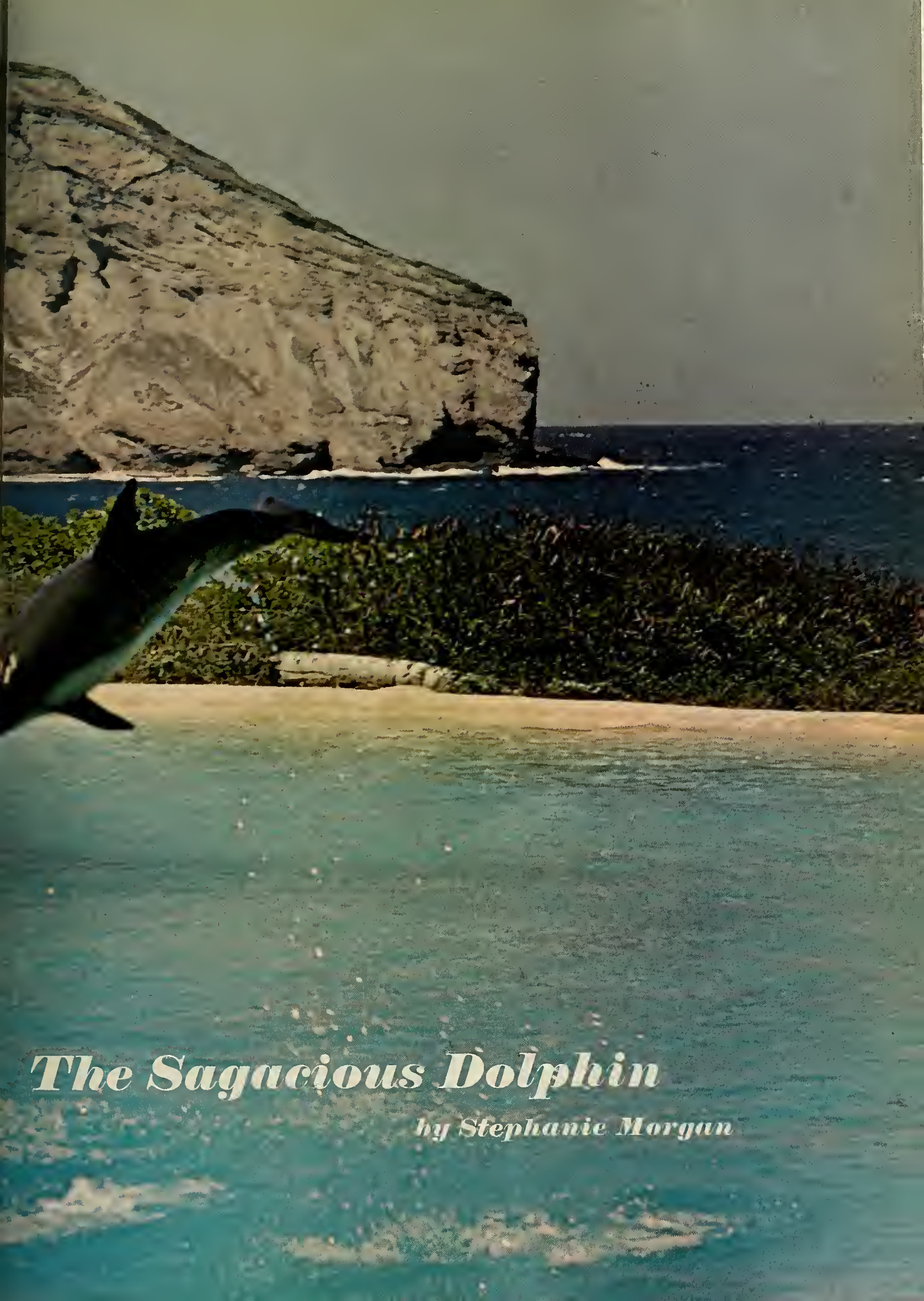
At the beginning of its own evolution a *de novo* form of life would be inconspicuous because of the many characteristics it shares with already existing life. If, for example, life begins easily at a number of hot springs, we are confronted with an almost uniform biotic pattern of sulphur bacteria and thermophilic blue-green algae. We might well not be able then to distinguish *de novo* blue-green algae from the lineal, unevolved descendants of blue-green algae that first appeared two billion years ago.

Angus Wood and others who have worked in our laboratory have gone on to propose that a form with somewhat different characteristics would simply be classified by the systematists as a previously unrecognized species. This explanation becomes all the stronger when we note that taxonomic studies of hot springs flora often turn up so-called new species.

One reason for performing experiments is to honor the general premise that with experiments we can unearth new understanding. We would otherwise be shut off from new outlooks by old unchallenged preconceptions. The experiments reviewed here have told us that the reactions leading to a model of self-replicating primitive life are rugged and could occur simply, rapidly, and often. The possibility now looms that as we learn more about how to produce life in the laboratory, we also come closer to recognizing that life can be originating spontaneously on our earth.

enactment of how a life process might begin in nature. bove: a mixture of amino acids arrives on a hot chunk lava. Right: water falls on the resulting amber-colored proteinoid to simulate rain. Below: a drop of runoff hows this abundance of self-organized microspheres.





The Sagacious Dolphin

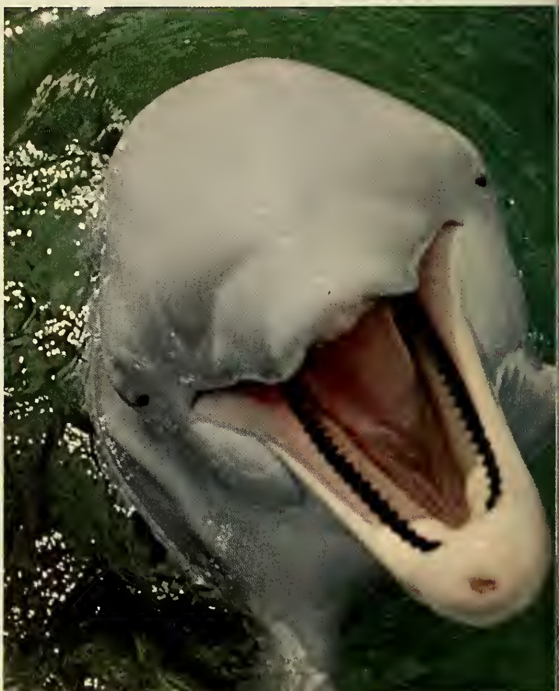
by Stephanie Morgan

Nineteen centuries ago near North Africa, as Pliny tells it, a dolphin came up to a boy in the sea, gave him a ride, and swam with him toward shore. Until just recently, this ancient Mediterranean tale of a friendly relationship between a man and a dolphin seemed no more than mythical. But now, as the two species approach each other more closely in aquariums and in the sea, the potential for co-operation between us seems to be more and more realistic. Despite the strangeness to humans of this sleek mammal and our strangeness to it as dry, stiff creatures with too many prongs, it may turn out that we have in common a quality more important than shape. We consider ourselves to be intelligent creatures; and dolphins, by the anatomical structure of their brains and by their behavior, show signs of being intelligent too. To what degree, by the standards we use to judge ourselves—and by whatever others we may find to fit them more precisely—is one of the first problems we must meet to determine on just what level our relationship will be.

Intelligence is hard to define. One might call it the capacity for individual adaptive behavior: for learning, by insight or imitation, how to react to new situations and how to modify one's actions effectively. For most animals, of course, high intelligence is unnecessary; instead natural selection, acting gradually, finds new action patterns and morphology to suit the needs of a species.

In a general way, intelligence does correlate with brain size; this was one of the first reasons why some

Equipped with sharp teeth, an underwater sonar system, and a smooth, streamlined body, the dolphin is superbly adapted for hunting in the ocean environment.



anatomists felt that cetaceans (including whales, dolphins, and porpoises) might be highly intelligent. A dolphin has a larger brain than a human, and its cerebral cortex is nearly as convoluted. However, the ratio of brain weight to body weight or body length (a common basis of interspecific comparison) favors man in both instances. Other comparisons might be made within the brains themselves. The cerebellum, which controls voluntary movement, is proportionately larger in cetaceans than in land animals. In neuron density, men surpass dolphins, but this may not be particularly significant because all small-brained animals (monkeys for instance) have a greater neuron density than large-brained ones. In the number of axodendritic interconnections between neurons, which may channel the associations on which intelligent choice is based, men surpass monkeys—and dolphins, men. In any event, such comparisons are tenuous, at best. Intelligence, as much as morphology, is a response to environmental pressure. Thus, an examination of the dolphin's environment, and its adaptation to it, is necessary if we are to understand the manifestations of this creature's intelligence.

Physically, despite its land-mammal ancestry, the dolphin is almost perfectly fitted to the generous but exacting environment of the sea. Breathing air, it spends its whole life in a medium physiologically alien, in the shelterless fringe where air and water meet, buffeted by both wind and current. Dolphins must always stay near the surface, even when sleeping. Often they hover just under water, rising every few minutes with a slow tail thrust, although precise sleep patterns are extremely variable. When ill or injured a dolphin must retain consciousness, for if it does not, breathing stops and it may drown. On the other hand, the sea is relatively tolerant of physical disability, as can be demonstrated by whales found handicapped but still managing to survive because of the ocean's buoyancy and abundance of food. The sea's complex moment-to-moment instability is balanced by the low magnitude of its seasonal and centurial changes. Since all the oceans flow into each other, water temperature and available food exert major influences on the limits of a dolphin's range. although other factors are also at work — territoriality, water depth, proximity to shore, etc.

Preyed on only by occasional sharks or killer whales, dophins are themselves superb hunters. With their sonar devices, they can locate widely scattered schools of fish. Since they are warm-blooded, they are able to swim at top speed for longer distances than a cold-blooded fish. The dolphin's body, shaped by the streamlining force of water resistance, is smooth as glass except for a few short whiskers on the snouts of fetuses, newborns, and very primitive river dolphins. The skin and the blubber coat beneath (which keeps a dolphin both warm and buoyant) help to reduce friction and turbulence. Horizontal tail-flukes drive him up for air, and the vertically flattened peduncle, just in front of them, helps it turn sideways as sharply as a fish, while delicate control of its flippers (modified forelimbs) aids in fine maneuvering. A dolphin's senses, which determine the world it actually lives in, accord, like its shape, to the sea environment. In one experiment, the eyes are reported to be backed with a glowing layer, like a cat's, presumably to help the dolphin see both in the dim world under water, and surprisingly, also quite well in the air. The sense of smell, which it has lost, may have been supplanted by tasting the sea water for spoor.

But the most expressive and most essential sensory medium for a dolphin is that of sound. Its hidden ears, unlike a human's, can judge direction under water, and it hears a scale of sound far exceeding ours. In air or in water, a dolphin can make noises ranging from whistles and clicks to what listeners call blats, mews, yelps, wails, and Bronx cheers. Most of these are thought to be produced inside the blowhole, although the site of sound production is the most bitterly contested problem in the study of cetaceans today. Controlled by all the muscles land animals use for facial expressions, the blowhole is a highly complex mechanism complete with air sacs, lips, and tongue. It is apparently capable of making two sounds at once—as if humans could whisper and whistle at the same time. Independently, in the larynx, a dolphin can produce directed "rusty hinge" sounds almost as high in the ultrasonic as those of a bat. and which are similarly used for echo ranging. At low frequencies, it can explore by ear for miles around; at high, it can "hear" shapes in detail. It may well be able to survey the insides of nearby animals, particularly their air-filled spaces. In this way, one investigator reports, a mother may become aware of gas in the digestive tract of her infant, and will burp it with her snout. Where primates must get hold of a thing and finger it, a dolphin can examine and learn at a distance, more precisely and without risking its safety.

The range of sounds they make and use suggests that dolphins may be able to learn not only through direct experience but also, to some unknown degree, from each other—an ability which humans most often tend to link with the potential of intelligence. But dolphins, with their perfect physical and behavioral adaptation, are so unlike us, or any land animal, that it is hard to judge just what criteria to use in gauging their intelligence. Humans are cultural animals passing on traditional behaviors within a social group. It seems reasonable to us that individual adaptability and rapid learning—intelligence—would be of the most selective value when one animal's flash of insight can be perpetuated to the advantage of all the group, perhaps even of the species.

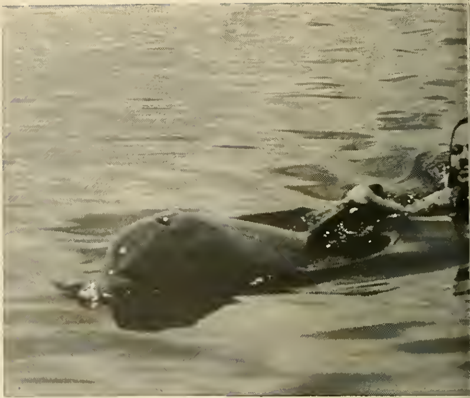
Some apes and monkeys—some birds, too—show traits of "culture," or "preculture" as such manifestations in animals are often termed. These traits are all widely different, for one of the major purposes of cultural behavior in non-humans is to improve their adaptation to their particular environment. But even a slight degree of learned behavior suggests a plasticity that could let an individual adapt relatively well not only to his own environment, but also to a variety of new situations—from a change in available food to a laboratory intelligence test. It seems that the amount of cultural behavior shown by any group of animals in a stable environment depends more on what it needs to get along than on its potential intelligence; that is, on

how much it is capable of learning.

This is exceptionally clear for human cultural differences. But Westerners in particular have tended to judge the ability of different groups of humans, and to rate their cultures, not by how well they adapt to their environments (which may require very little material culture). but by how well they control them. Actually, no matter how simple its material aspects, every existing human culture softens the environment's action so much that what its members adapt to most, individually and genetically, is the culture itself. Culture is man's environment and selects him for the flexibility of intelligence that lets him learn to adapt to it. So intelligence, to our way of thinking, depends essentially on culture in its aspects of transmitted tradition (which calls for communication) and of manipulation, meaning some degree of control over the environment.

Communication can be seen as a kind of tool for thought. The symbols or signals used in communication between individuals (and generations) can also be used by any one individual to build up in his head a picture of his world, in which he can test his behavior before committing himself to action. We call this insight. To judge by its behavior, a dolphin's inner pictures may be as neatly fitted to complex reality as its external communications are elaborate. It can manipulate with surprising flexibility, although seemingly without the aim either of adapting to or controlling its environment. Where this leaves us, in our search for culture as a path to intelligence, is hard to say. Perhaps our idea of the connection is overly limited. Perhaps dolphins do have "culture," but because it differs from our own, and because of our biases and incomplete techniques, as yet we fail to recognize it.

The human emphasis on control and manipulation as cultural basics and signs of intelligence derives from the long trend of our own evolution. Humans, in fact, are animals whose brains, bodies, and behavior have been transformed to a large extent by the tools they had to learn to use. Facing the drought and deadly carnivores of the Pliocene, the human ancestor had little beyond his two primate hands, evolved for gripping branches and freed by increasing bipedality. With bones and sticks at first, later with stone, he gave himself the crushing and tearing power of a leopard's jaws. The success of this earliest culture, and of our ancestors as tool-using predators, set up a spiral of increasingly elaborate cultural adaptations. With more to learn, children remained a helpless burden to their mothers for a longer period of time. Increasingly, males had to co-operate in group protection and in the hunts that females could not join. Thus, the first specialization, the first cultural complication of society, called for greater individual flexibility. Indirectly then, and directly via the need for co-ordination of eye and hand, the cultural use of tools selected for increased brain size,



and ultimately, for the minds that now look speculatively at dolphins.

From the human viewpoint, then, intelligence is the response of a frail but dexterous animal to an environment either persistently hostile or, like the Pleistocene, undulatingly unpredictable. The sea is all of that for mammals. To the earliest dolphin ancestor, who might perhaps have paddled with four feet and a stout tail in swamps and rivers some fifty million years ago, the problems posed by a permanent life in the water might have been severe, indeed. Besides the physical and physiological stresses already described, when this small cetacean managed to work its way into the Paleocene oceans it found an ecological niche already occupied by the sharks. At present, sharks may kill a single dolphin, but dolphins in groups can keep sharks at a distance, or kill one by ramming its gills. This tenuous balance of power may have been something the dolphins had to fight for. Clearly, co-operation and a cohesive social organization were necessary early values in the dolphin's world, not only for defense, but also for hunting and for security against the potential hazards of the water itself. So, today, dolphins join to encircle schools of fish; or if one member of a dolphin group is hurt and unable to surface, it may give a "distress" call, and other dolphins—even strangers from a different sea—will rise under its flippers and hold it up to the air. The same two problems of food and air might have contributed to the development of cortical control of behavior. If at any depth a hungry dolphin's air supply gives out just as it is closing in on a fish, it is faced with a swift choice of which drive to suppress; it must not let itself be caught without air at too deep a level to rise. Even to surface it must compute a sheaf of variable alternatives, particularly during stormy weather.

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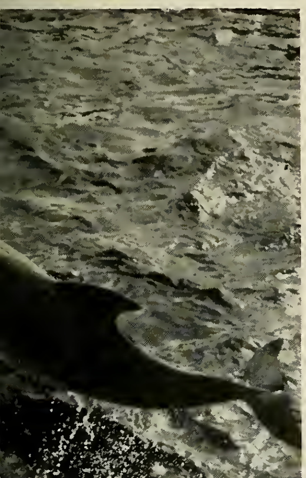


Although all of these problems—sharks, hunting food, deep water—call for intelligence and co-operation, they have been met, in a large part, by changes in the dolphin's body rather than by cultural adaptation. One prime value of culture is that it can adapt faster than morphology to environmental differences. The sea, whose main selective barriers occur between climatic zones, has changed cetaceans more than they have changed it; and the different cetacean species are only found within the limits (often broad) of their physical tolerance. Being powerful hunters, they have no need to control the environment on their own initiative by using tools. So despite their co-operative social groups, they show no culture as most humans define it. However, this perfect adaptation to sea life could mean that dolphins can, by now, take for granted the ecological basics that preoccupy human cultures. They may now—and this is highly speculative—turn their conscious intelligence to abstract elaborations on the pattern of human art, and ideology; or to expressions of social relationships; or to play.

If standard tests and behavioral observations support this point of view, then it would seem that the human derivation of intelligence, via the evolution of manipulative culture, may hold true for humans but not necessarily for dolphins. Possibly, as theories propose and studies seem to uphold, the culture or "preculture," of the dolphins may emphasize communication, rather than environmental control.

Formal problem-solving experiments to test dolphins' intelligence are difficult to design and carry out. An experiment of this order must not only fit their physical and sensory ranges, but also it must suit their less obvious psychological requirements. Dolphins generally are not greatly responsive to fish rewards; the problem has to be one that motivates them more highly in itself or as a sport. But it should not be overly frustrating. After making several errors in a taxing experimental situation, one dolphin became so emotionally upset that it grabbed up a plastic pipe in its jaws and broke the test apparatus with it. An experiment with dolphins could easily be spoiled by an experimenter's ignorance of such things as their dislike for swimming through narrow openings, and, curiously, of the colors white and black (dolphins at Marineland of the Pacific, California, delighted in splashing the black-clad Catholic clergy). If dolphins are appropriately treated and if the experimenter has an ongoing, familiar relationship with them, they can show an extraordinary ability to solve problems both by imitation and by insight. A dolphin can learn to do a startling variety of acts using any part of its body that it can move. It can learn five or six new procedures at a time, often by being shown or by seeing another dolphin learn, and it can actively and rapidly modify its own natural behaviors until it finds a new one that gets results. Experiments and training now provide fewer, but more formal, examples of these capabilities than does the dolphin's natural behavior. Eventually, with time and progress, there will be many more studies like that by Drs. Winthrop Kellogg and Charles Rice of the annoyed dolphin mentioned above. Despite its early mistakes, it kept straight (some up to seven months) an array of scrambled pattern discriminations that at times confused even the experimenters.

Dolphin behavior, as far as we

know it from the usually fragmented groups mixed by chance in our limited pools, is lively, complex, and versatile. In many details their social life bears an almost eerie resemblance to that of higher primates, and their patterns of play are suggestive of what we tend to think of as real, manipulative culture. They are intensely interdependent, in ways more structured than simple co-operation. One group, which may be typical of those in the wild, lived for four years at Marineland of Florida. It consisted of a massive, aloof, and dominant male; his five females and their three infants; and a few older offspring—young satellite males. Individual ties within the group were lasting, particularly between one mother and her older daughter—a bond recently found in rhesus monkeys and put forward as a possible origin of human family life. Both males and females caught their own food. One sign of a division of labor (also found in chimpanzees, but never so formally) was that one young female took over and "baby-sat" for all the infants, while the mothers went off to feed. In the wild, when females leave for high-speed hunting, the same division of labor might be necessary. The complexity and vigorous emotionality of dolphin social life were best displayed in their sexual behavior, which, like that of many primates, generally came to a peak in the spring, but (for young males, at least) was lively in any month. The big male chose one female at a time to be his consort, calling her with a special yelp, and they courted in ways ranging from gentle stroking with flippers or flukes, to a powerful rush straight at each other, veering at the last instant to rub forcefully together. The young males, still immature, tried zestfully to court and copulate as well, but the big male always intervened, furiously bit them and tail-slapped them against the tank wall. Frustrated here, the young dolphins tried again to mate with the infants, green turtles, and each other, with enthusiasm, but hardly any more success. Like all young primates, including humans, they seemed to make a game of sexual learning, and certainly no innate direction told them what to try.

In affection or discipline, dolphins use their bodies to react to each other, and in play, sexual or not, young and old do the same with objects. Manipulation in the broadest sense is not just handedness—nor is it the use of toes or proboscis. Manipulation is more of an attitude: an object is made to do what an individual wants it to, whether directly or by means of another object. Dolphins play tag sometimes for as long as half an hour. They play with balls or inner tubes and show a nice sense of underwater dynamics, as well as foresight. In one case, a dolphin tucked the buoyant objects under an overhang for safekeeping until it came back later. This predictive ability comes most into use when dolphins tease other animals. Prankishly, they may tug the feathers of a sleeping pelican, lure a fish from its hole with a piece of food, which they then snatch away, and throw tubes out of the tank for humans to fetch. Once confronted with a stubborn eel, a dolphin went and found a scorpion fish, killed it, and used its spines to poke the eel out of its hole. All this energy and insight, this real toolmaking, were for fun, just as the pipe-wielding dolphin used his tool only in an instant's aggravation.

Invention, persistence, and imitation of behavioral patterns: dolphins seem to have all the elements of culture—culture used in play. Yet, it is not an ecological tool. It leaves no lasting mark. In the wild, dolphins probably have no time to use elaborate methods to get the masses of food they need, although if they had to—if schools of fish grew scarce—they undoubtedly could learn new methods. The ability they show on the manipulative side of culture, then, may not reflect their ecology.

The more some scientists study dolphin communication, the more they feel that they may be faced with a complex and codified language though one very hard to understand. So far, most specific sounds that have been correlated with behaviors seem to be expressions of emotions or social interactions, like the mating yelp. Dr. John Dreher, who fed recorded sounds into a tank and noted the dolphins' responses, identified query or search provoking "chase me" calls. This might reflect the experimental technique, or it might mean that dolphins do communicate mainly about feelings and complicated social relationships. Calls may be signals referring to immediate situations, rather than displaced symbols reflecting concepts distant in time or space, as in human speech.

Attempts to study dolphin language are complicated by the dolphin's lack of real external expression except by orientation, eyes, and the mobile blowhole, which in any case may not be seen at a distance. Land animals inadvertently express their real intentions by the way they emit information and by physical clues—a dog's tail wagging while he growls suggests that he does not mean to bite. The "paralanguage" directly expresses emotional intensity—the faster the tail wags the better the dog feels. Dolphins might have to convey their emotional shades of meaning by sound, and not directly—by wholly arbitrary signals. On the other hand, if one dolphin can "look" inside another, by means of echo ranging, and know how the air in its stomach and lungs is behaving while it communicates, possibly the emotional context need not be spelled out by vocalization.

Echos, received from these and other shapes, could serve as direct, displaced symbols ("words") for emotions, objects, or individuals, if a dolphin could retransmit them. Arbitrary paralinguistic relationships might be even more readily displaced and serve as symbols of situations, as those for emotions could serve for ideas. With these, the dolphins would have the start of a language able, like man's, to shape the environment without touching it—by clarifying it, putting it into categories. We know that dolphins have both foresight and memory, and that they enjoy playing with sounds as human babies do. Two dolphins linked by phone, each isolated and immobile in its own small tank, will exchange various sounds, rarely overlapping, as long as they can hear each other.

But most thought provoking are the dolphin's "language" exchanges with humans. While old wild dolphins make complex and intricate sound patterns, young captives make atypical noises and patterns. After human contact, the youngsters may rapidly switch from these to what

Dr. John Cunningham Lilly, M.D., calls "humanoid emissions"—as if learning from us modes of communication through sound patterns that, in the wild, they would have learned from their elders. If reinforced, a dolphin may start to repeat almost faultlessly the exact number of sounds that humans give it, and eventually, the sounds themselves. It may say much more than we can catch, for it often speeds up and compresses the words in a way that indicates more than simple parroting. The ability a dolphin shows here, on the vocal level, to reshape its internal signals for a purpose, and to recombine muscles evolved for other uses, is the same as that which it often shows in its manipulative play. Language, then, may be the key to dolphin intelligence. It requires learning and facilitates adaptive behavior, and it could have been selected, just as human language probably was, for group co-operation and direct interaction. We still have no idea how else it might be used; whether it could be the vehicle for abstract and creative thought, cultural traditions that most humans would put second to the tool-based hunt for food. We can only judge by its effects, the "sparking-over" into action of the versatility for which it would call. Dr. Lilly believes that this is the level on which man and dolphin may best approach each other, and one of his assistants, Margaret Howe, lived for two and a half months with a young dolphin in water a little less than knee deep, trying to teach it English. Neither was comfortable, but the dolphin learned to shape its sounds to hers, in spacing and, finally, in structure; and the mutual accommodations brought them closer in more ways than human and dolphin have ever been before.

Partnerships like this may set the pattern of the future. In our typically human fashion, at great outlay of technological equipment, we are beginning to invade the sea, for knowledge and for food, and for purposes to which the sea is only incidental. There we find mammals who came far ahead of us, who had solved the problems we now face when our own ancestors still scuffled in trees, and who show a good will and a responsiveness that suggests they might be willing to help us learn. The different mental idioms that we employ handicap our interaction; that the dolphin intelligence, bred to the restless sea, fits our criteria as well as it does is a tribute to the flexibility of both sides. This, we trust, will bring us together. For our own benefit, dolphins could, if they wanted, become our symbiotes in the organization and control of technological fishing. And even more valuable to science, they might join us on the level where our two species overlap most, that of communication, somehow making available some of their unimaginable practical knowledge of the currents, the other inhabitants, the reefs, and the depths of the sea.

While the extent and nature ɔlphin "language" are unknown, the greatest opportunity for meaningful interaction between ɪn and dolphin may well depend the discovery of communication links between the two species.

Editor's Note: Next month, Natural History will publish another article on dolphins. The coauthors, Drs. Melba C. and David K. Caldwell, are engaged in dolphin research at Marineland of Florida in St. Augustine.

PHOTOGRAPHY BY GEORGE TICE

A sampling of photographs
a sampler of verse
devoted simply to

TREES

LEAVES COMPARED WITH FLOWERS

A tree's leaves may be ever so good,
So may its bark, so may its wood;
But unless you put the right thing to its root
It never will show much flower or fruit.

But I may be one who does not care
Ever to have tree bloom or bear.
Leaves for smooth and bark for rough,
Leaves and bark may be tree enough.

Some giant trees have bloom so small
They might as well have none at all.
Late in life I have come on fern.
Now lichens are due to have their turn.

I bade men tell me which in brief,
Which is fairer, flower or leaf.
They did not have the wit to say,
Leaves by night and flowers by day.

Leaves and bark, leaves and bark,
To lean against and hear in the dark.
Petals I may have once pursued.
Leaves are all my darker mood.

Robert Frost

NEVERTHELESS

you've seen a strawberry
that's had a struggle; yet
was, where the fragments met,

a hedgehog or a star-
fish for the multitude
of seeds. What better food

than apple-seeds—the fruit
within the fruit—locked in
like counter-curved twin

hazel-nuts? Frost that kills
the little rubber-plant-
leaves of kok-saghyz-*stalks, can't*

harm the roots; they still grow
in frozen ground. Once where
there was a prickly-pear

leaf clinging to barbed wire,
a root shot down to grow
in earth two feet below;

as carrots form mandrakes
or a ram's-horn root some-
times. Victory won't come

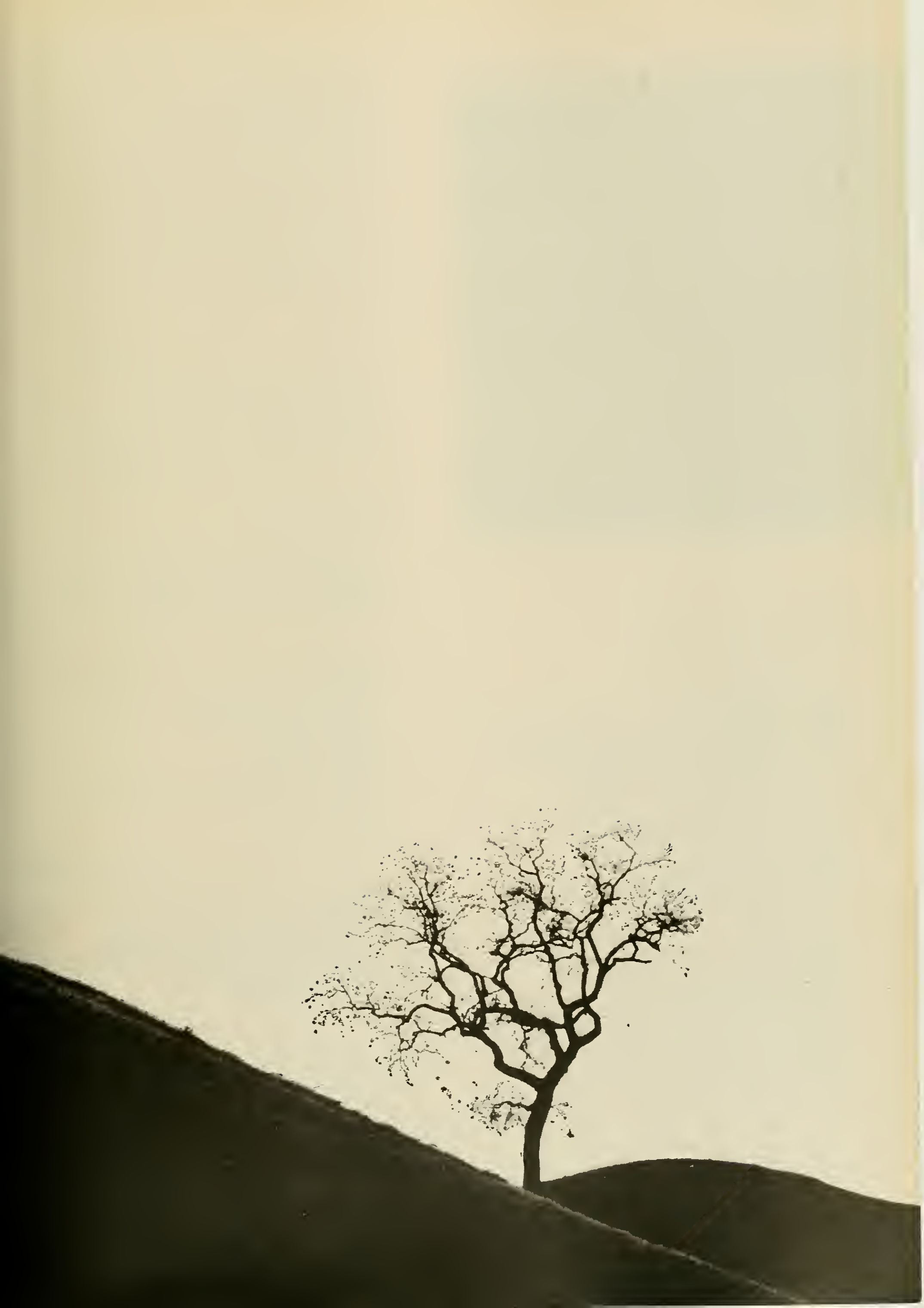
to me unless I go
to it; a grape-tendril
ties a knot in knots till

knotted thirty times,—so
the bound twig that's under-
gone and over-gone, can't stir.

The weak overcomes its
menace, the strong over-
comes itself. What is there

like fortitude! What sap
went through that little thread
to make the cherry red!

Marianne Moo



MORNING DIALOGUE

THE YOUNG MAN

That way the moonflower and the sunflower this
and the garden path that winds between
how can I know what they may mean
in the confusions of my delight?
Old mother oak
whose ferrule is on my forehead
whose mast is on my tongue
tell me, for I am young,
what language I should speak?

THE OAK

Speak with the language of the leaf
when what you mean is brief
and with the language of the bough
when what you mean is more than now
but also learn while you are young
speech is not only of the tongue.

THE YOUNG MAN

This calyx of cerulean blue
now magnified by one clear drop of dew
becomes tremendous in the sun
and every one
of these small dots of cinnamon
seems like a world about to run
into the fiery histories of space
how can I face
these miracles and have no speech?

THE OAK

I reach
from earth to sky, from one to other,
have no sister and no brother
from the dark underworld
crammed with richness and with death
seek out my way to leaf and breath.

THE YOUNG MAN

What love is this
that can dispense with words
or all but such as bud and fade and fall
heedless of the song of birds
once more to earth that buries?

THE OAK

North wind begins his autumn flurries
a solitary leaf descends
and something ends.
You too must die
and so must I
yet each with different speech can say—

THE YOUNG MAN

—What can we say?

THE OAK

I have forgotten. Something simple—?
That night is night, and day is day.
Or that the languages of sap and blood
are only wood and word
and therefor good.

Conrad Aiken

SKY REPORTER

A THREAT TO MARS For centuries man has introduced foreign plant and animal life to new lands—sometimes deliberately, sometimes inadvertently—often with catastrophic results. Now that he has landed instruments on one planet and is preparing to do so on another, some scientists have raised the specter of the wholesale contamination of an entire planet.

Carl Sagan, Elliott C. Levinthal, and Joshua Lederberg, writing in the journal *Science*, urge the United States and the Soviet Union to agree now to take every precaution against contamination while space exploration vehicles are in the planning and design stages.

They argue that military experiments with micro-organisms in bacteriological warfare indicate that some organisms will survive even a crash landing. Water may be available to such organisms near areas of geothermal activity, in underground permafrost, or even in underground streams.

The authors suggest that certain types of organisms might lie dormant until man himself arrived decades later and created the conditions in which the organisms could thrive. They ask the U.S. and the U.S.S.R. to commit themselves to the most complete sterilization of their spacecraft possible. They point out that the Russians may be planning an instrument landing on Mars during next year's opposition, and any contamination at that time would make future biological exploration of Mars useless.

COMET SPLITTING Long-period comets have a habit of splitting up as they sweep around the sun, even when they do not come close enough to undergo fatal tidal forces. Comet splitting has been observed at distances from the sun ranging from 0.2 to 4.9 astronomical units (an astronomical unit is the mean distance from earth to sun, or about 93 million miles).

Many of the splits have occurred on or very near the ecliptic. This fact has led Martin Harwit of Cornell University to suggest that the splitting may be the result of collisions between the comets and interplanetary "boulders"—meteorites on the order of 33 feet across.

Writing in the *Astrophysical Journal*, Harwit proposes that the force of the collision itself could cause the split, or the collision could cause sudden heating that, in turn, would result in a split. He notes that the force of the collision would be enough to produce a crater about 109 yards across.

According to Harwit, the nuclei of the long-period comets range up to 31 miles in diameter, or up to five times the size of ordinary periodic comets. This alone would increase the possibility of collision. Further, while the periodic comets and the boulders tend to move around the sun in similar, more nearly circular orbits, the long-period comets come looping in from beyond the farthest planet in highly elliptical orbits at sharp angles to those of the boulders.

Harwit suggests his theory can be tested in two ways. If comets having retrograde orbits (going against the traffic around the sun) can be shown to split more often, this would add weight to the collision hypothesis. And, if the sudden flaring sometimes observed in comets is found to occur on or near the ecliptic, where the boulders are, this would be further confirmation.

TIMEPIECE IN SPACE One of the most exciting chapters in modern astronomy opened last winter with the discovery of rapidly pulsating radio sources, or pulsars. Since then there has been a deluge of new observational data—including the recent discovery of a light flash at one source that varies in brightness at half the radio pulse rate—but the question of what the pulsars really are remains unanswered.

Frank D. Drake, who has been studying the pulsars with the 1,000-foot radio telescope in Arecibo, Puerto Rico, suggests, in *Science*, ways in which astronomers can use the pulsars despite not knowing what they are.

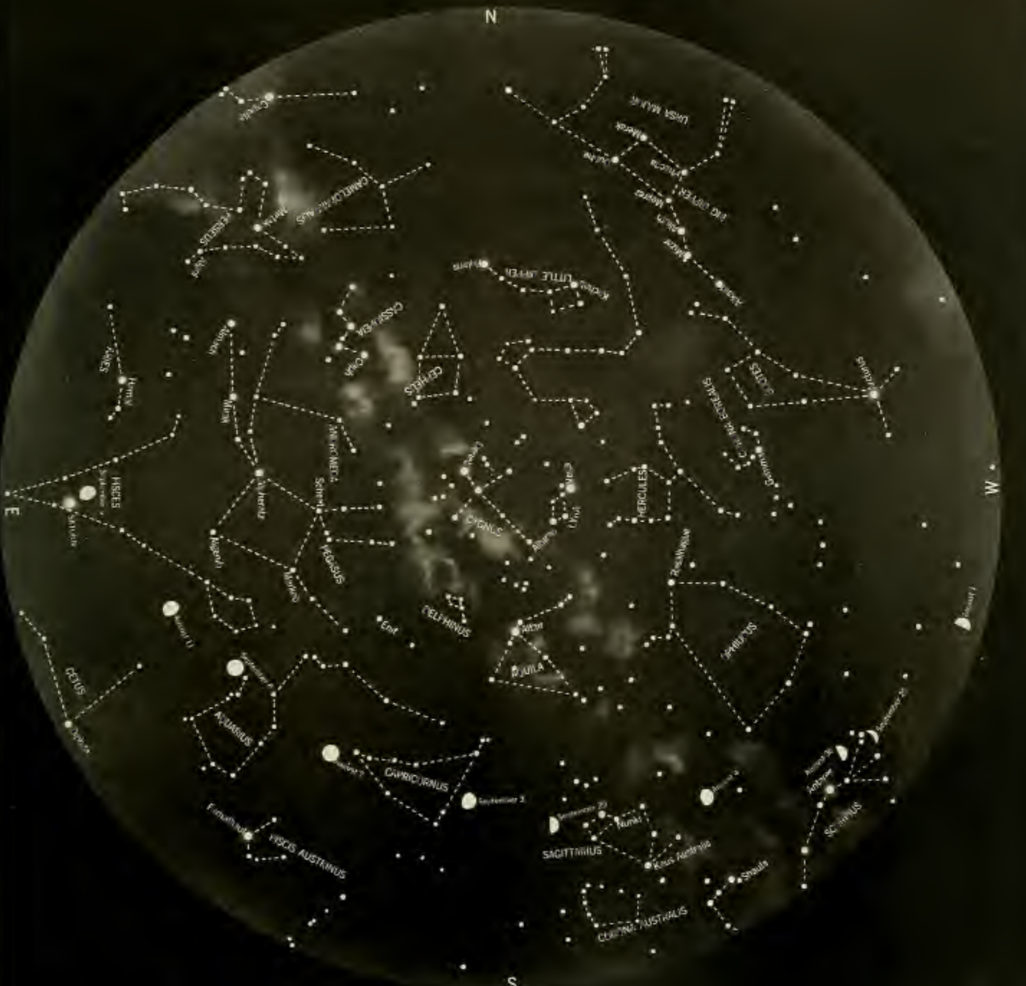
The periods of the pulses are so precise that a deviation from linear motion of as little as 18.6 miles can be detected. Since stars do deviate from linear motion as they rotate with the Galaxy, the pulsars can help map our Galaxy. Also, because of the pulse precision, the pulsars could be used as a time service. In some areas of the world, it might be easier to receive "time signals" from the pulsars than from the time service broadcast over radio stations on earth itself.

Finally, the effect of interstellar electrons on the arriving pulses can be measured, allowing astronomers to measure the electron density and thus the plasma distribution in our Galaxy.

VARIABLE THAT STOPPED Mysterious RU Camelopardalis, a variable star in the polar constellation that quietly stopped varying in 1965, remains in astronomy's "Unsolved-Active" file. The star had varied between eighth and ninth magnitudes in a 22-day period since 1907, when it was first noticed. Why the star stopped pulsating is still not known, but astronomers are studying RU Cam for clues to its behavior. They particularly want to pin down its composition, so they can watch for compositional changes if the star resumes pulsating.

George Wallerstein of the University of Washington has reported in the *Astrophysical Journal* some results to date. Using the 120-inch Lick reflector in California, he found the star appeared to have excess carbon in its atmosphere, a sign that elements from the interior have been brought to the surface by a violent mixing process. He suggests that the star is in a rapid state of transition, and says it may represent a brief stage of evolution following an instability brought on by rapid nuclear burning in the interior.

JOHN P. WILEY, JR.



CELESTIAL EVENTS

First-quarter moon occurs on August 1, full moon on the 8th, last-quarter on the 15th, new on the 23rd, and first-quarter again on the 30th. In September, the full moon occurs on the 6th, last-quarter on the 14th, new moon on the 22nd, and first-quarter on the 29th.

Except for Saturn, the planets are difficult to see in August and September. Saturn rises during the evening and is visible, among the faint stars of Pisces, until dawn. Venus and Jupiter set during evening twilight. In September, Venus becomes brighter and easier to see, but Jupiter goes through conjunction and becomes a morning star.

August 7: Mercury is at superior conjunction, on the far side of the sun as seen from earth, and enters the evening sky. Saturn is stationary in right ascension and begins to retrograde.

August 11: The Perseid meteor shower, one of the best of the year, reaches maximum. Meteors of the shower may be seen for several mornings before and after this date, but the waning gibbous moon will be in the sky.

August 14: The bright object to the west (right) of the moon in this morning's sky is Saturn.

August 27: The bright star to the west (right) of the crescent moon tonight is Spica, in Virgo.

September 9: Shortly after moonrise, you can find Saturn below and to the left of the moon. During the night, the moon passes north of Saturn and follows the planet into the western sky by morning.

September 22: The sun arrives at the autumnal equinox at 6:26 P.M., EST; autumn begins in the Northern Hemisphere.

September 24: Venus is below and to the right of the crescent moon in the evening twilight sky.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 11:20 P.M. on August 1; 9:23 P.M. on August 31; 7:20 P.M. on September 30; but it may be used for about an hour before and after those times.

Blue-green Havasu Creek, a tributary of the Colorado flows over two-hundred-foot-high Mooney Falls as a storm hovers over the distant canyon rim

Lightning Water

Flash floods, those wildly beautiful desert hallmarks, serve as a healthy reminder that nature on the rampage can quickly reduce to utter helplessness the careless individual or the person who naïvely assumes that the whole of the natural world has been "conquered." Strangers to the desert cannot believe that a sandy gully, which looks like a good place to camp, may become, without warning, a raging flood—a wall of water several feet high plunging forward with enormous speed and force.

Reclamation engineers, operating under a variety of names, are making a concerted effort to tame or conquer these floods—along with everything else that is free and natural. Their rationale often alludes to the fact that people have sometimes been drowned in them; but people have been killed rather more often in highway accidents, and no one talks about the necessity of eliminating automobiles. Perhaps the real reason for the often intemperate enthusiasm of the reclaimers is that the projects they dream up will provide them with jobs.

Like the road builders, the reclaimers are inclined to see needs where no one else can, and their consequent boondoggling threatens to destroy a large portion of the remaining natural environment. When every stream has been dammed and all the countryside has become a mere network of roads, their triumph will be complete—America the Beautiful will have become America the Conquered.

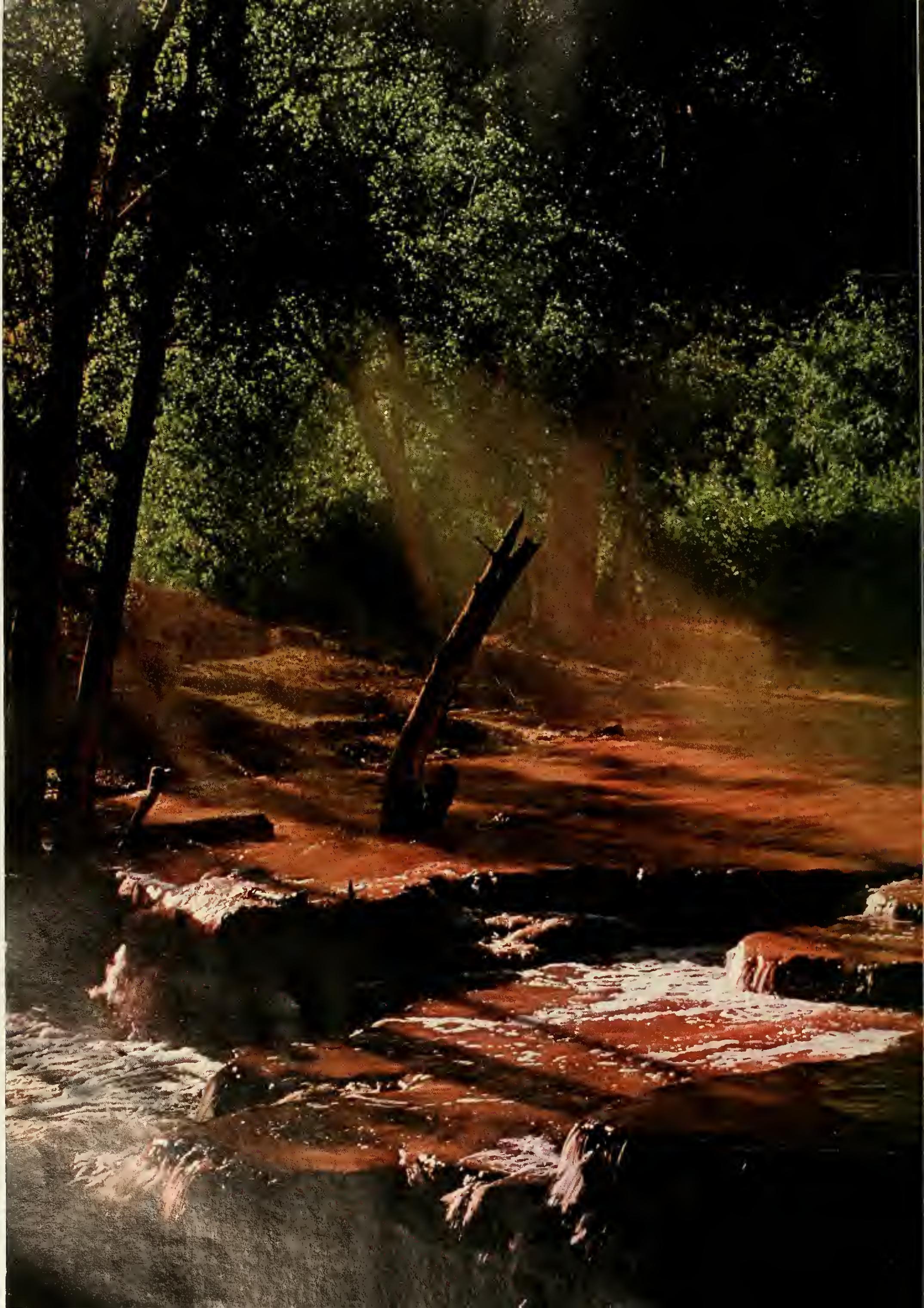
If we would only begin to question our naïve faith that the road and dam builders "must know best because they are experts"; if, instead, we would only realize that the first concern of all of them is their vested interest in their own jobs, rather than in the public good, then their pointless vandalism of our countryside might be stopped. But this realization is likely to be too late in coming.

It doesn't rain often in the desert and the total annual rainfall is small. But when it does rain, the water often comes down in torrent proportions. This is one reason why the flash flood is primarily a desert phenomenon. Death Valley in California furnishes an extreme example. It is the driest spot in the United States. Average rainfall is about 1.5 inches and more than a year has been known to pass without a measurable trace. Yet in July, 1950, a cloudburst (a convenient but not very meaningful term) produced a flood which cut a six-foot-deep gully across the main road and rolled along boulders five feet in diameter. In Arizona more than five inches of rain has fallen in a twenty-four-hour period; as much as eleven inches in the course of one storm. These are exceptional figures, but very heavy downpours within a short time are usual.

The other principal reason why the flash flood is almost exclusively a feature of the desert is that nearly all the water that falls in a torrential rain runs off. Vegetation ground

by Joseph Wood Krutch □ photographs by Don Valentine

Within minutes of a summer storm, Havasu Creek expands to flash flood proportions. After passing over Havasu Canyon, the lightning storm drifts into the desert night.



ver is sparse or nonexistent. The rface of the ground is often baked an almost bricklike consistency. ery little water is absorbed. Most of runs off into the dry riverbeds cut r previous floods. These gullies are nong the most characteristic fea-res of arid lands and are called by variety of names—dry wash or draw Arizona, arroyo in California, adi in the Near East. Some of the oodwaters that periodically rage rough an arroyo sink into its usu-lly sandy or rocky bottom. A few et below the surface, the soil may e damp while that of the surround-ng desert floor is completely dry. he difference in moisture creates a pecial environment for plant life. lear the borders of the dry wash ere may be cottonwoods that cannot urvive the desert and a special spe-ies of palo verde trees, which needs ust a bit more water than the easily listinguishable species that grows in nore arid situations.

Another geomorphic feature cre-ted by the flash floods is the alluvial an—characteristic of desert regions ordered by mountains. These are lelta-shaped accumulations of sand and rock, deposited at the point where mountain ravines open onto the desert floor. Torrents arising from storms in the mountains plunge down these ravines, finally dumping their debris when their speed is reduced by emergence onto the flatness of the desert. Especially striking specimens can be seen in Death Valley. They look rather more like glaciers than like the flood deltas of moister regions, and they are among the most graceful of land forms.

Most paved roads in the desert are crossed at frequent intervals by dips that conduct the water across the roadbeds. These dips, too, may be dangerous in flood season. Neither the pedestrian nor the motorist can quite believe the force of the water that occasionally rushes through these dry beds. But the presence of automobile-sized boulders in the arroyos attests to the carrying force of the water which increases enormously with an increase in speed.

It is said that the carrying power of a stream varies as the sixth power of its velocity. But whether or not this figure is entirely accurate, all the lay traveler needs to remember is that an increased speed of flow increases manyfold the stream's power to sweep heavy objects along with it. He must not assume that because the flood doesn't look much swifter than it did when he crossed it safely a short time before, it is probably still safe. If he makes that assumption, he may be in for trouble. Flash floods are dangerous only if you don't take the trouble to know what they are and why they exist. But to some of us it seems that it would be better to teach people how to travel or live in the few remaining natural areas than to destroy their unique characteristics.

The ultimate endeavor of the reclaimers is to homogenize the American earth, which today presents an infinite variety. The more it is crossed by freeways and the more its streams and lakes are regularized by engineers, the more every part of it will look like every other part. It will no longer be worth taking the journeys from one region to another that the superhighways are supposed to make so easy and so quick.

The Southwest without the flash floods would be no longer recognizable, no longer unique, no longer beautiful in its own way. We have begun to hear some talk about preserving a few wild rivers, and the flash flood is the wildest of all wild rivers. On the other hand, the reclaimers seem determined to tame everything capable of inspiring awe and to put everywhere in its place the tame, the uniform, and the convenient. They are making this a far less interesting world. ■

The morning after: Havasu Creek, still burdened with silt, returns to normal.

COMMUNICATION AMON

While preserving man's wealth of languages, we can achieve worldwide communication by adopting two languages and a system of signs that will be universally understood

Long before modern technology brought the peoples of the world within speaking distance of each other, prophets and philosophers had begun to think about the possibilities of universal languages that would remove the dangers symbolized by the story of the Tower of Babel. In the Western world, there have been serious attempts to invent new languages based on European grammatical forms. It was hoped that these languages would do what Latir once did for the tiny literate medieval European community and wha diplomatic French did for the nineteenth-century political community Esperanto was the language mos vigorously pursued by idealistic en thusiasts. Interlingua, a written sci entific language, is a current attemp to provide those of us whose lan guages are Indo-European with bet ter forms of communication.

Since foresighted individuals firs began thinking about these problems however, the world has changed While new technologies have mad

by Margaret Mead and Rudolf Modley

LL PEOPLE, EVERYWHERE

former dreams obsolete in detail, they are still relevant to the world's needs. Today we have to deal with new and demanding conditions. Anyone on this planet can travel to any part of it in 36 hours. But the people of the earth speak some 2,800 languages, and it would be impossible to provide enough interpreters at airports to aid these potential travelers. Even the simultaneous arrival at an airport of aircraft from a variety of countries, whose pilots speak only their own languages, occasionally causes difficulties at control towers.

These conditions present a challenge to the inventiveness of the modern world. To people who cannot travel, get on and off trains, ships, and airplanes, or find an inn because of language barriers, the new freedom of movement is meaningless.

The Instantaneous Message

A first requirement, then, for our technologically developed world is a set of clear, unambiguous signs that can be understood by the speakers of any language, and by the members of any culture, however primitive. These signs will enable mankind to use the great new freedom of worldwide travel. Without them, hungry, frightened, confused people will continue to clog the travel lanes, come to grief on the roads, return disenchanted to their small provincial worlds, and contribute to the isolation and hostility in which many human communities live today.

Such signs are necessary for all travelers—for the boy riding a bicycle as well as for the motorist in a large city. We call these signs glyphs.

Glyphs are the only universal graphic communications device that is in public use. They are beginning to appear on highways, in world's fairs, at hotels and inns, and on machines and appliances the world over.

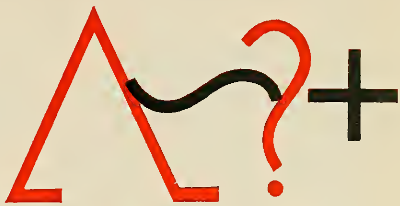
Glyphs communicate visually. Their message provokes "visual thinking" instead of "verbal thinking." Visual thinking has a direct and immediate impact on the viewer: a picture of a horse is an image of a horse to all men. No further interpretation is required. Verbal thinking, on the other hand, requires a more complex process. The word *horse*, or *cheval* (French), or *Pferd* (German) has to be heard or read first, and only then (if he can speak or write the specific language) can the intended recipient of the message interpret the meaning.

The advantages of a glyph are thus twofold:

1. Glyphs don't require knowledge of a language, spoken or written. The message of a glyph is unambiguous, simple, and understandable to anybody who has once "learned it." An arrow pointing right means "turn right"; two moving legs mean "go."

2. Glyphs create a direct and immediate impact and thus permit immediate response. This applies as well to those who know a language as to those who do not. This immediacy of response saves thinking. What Alfred North Whitehead has said of mathematical notations applies also to glyphs: "By relieving the brain of

Glyphs—universal graphic symbols—should be immediately understandable. A symbol that shows an object's image fills this need, but such symbols (the telephone, for example) may become badly outdated. Concept-related symbols—the bent arrow (turn right), walking legs (go), and wavy line (water)—are clear and timeless. The question mark and plus sign are arbitrary symbols and give no clue to their meanings.



all unnecessary work, a good notation sets it free to concentrate on more advanced problems."

Graphic symbols (of which glyphs are those selected for worldwide communication) can be image-related, concept-related, or arbitrary.

An *image-related graphic symbol* refers to the real object by resemblance in different degrees of "fidelity." A symbol for a cow would be an image-related symbol if it were to show a silhouette of a cow. Image-related symbols have the great advantage of being easily recognized, easily learned, and easily retained. But it would be wrong to jump to the quick conclusion that such symbols are the ones we should always choose for glyphs. One trouble with image-related symbols is that in these rapidly changing times the objects that the symbols represent change frequently with technical innovations, new packaging, and fashion. An image-related symbol of an automobile, created today, would look out of date a decade from now. The same is true of locomotives, clothing, airplanes, and of many products that require packaging.

Concept-related symbols tend to have a longer life-span. The horizontal wavy symbol for water, the directional arrow, the vertical wavy symbol for smoke or fire are more representative of our idea of water, direction, or fire than of the actual visual image. Yet, the symbol will be clear to people of most cultures; and once learned, it will be easily retained and recognized.

Finally, we have *arbitrary symbols*, which have no visual relation to an image or a concept. Because of this, such symbols are more difficult to teach, more difficult to learn, and harder to retain and recognize.

The graphic symbols in current common use, such as letters and numerals, punctuation marks, and mathematical operators, are all arbitrary symbols. Some have developed over centuries, others over thousands of years, often after competition with other symbols. This is especially true of mathematical notations. Early in the year 1696, Gottfried Wilhelm Leibnitz, one of the major developers of mathematical notations, said in a letter: "As regards signs, I see it clearly that it is to the interest of the Republic of Letters and especially of students, that learned men should reach agreement on signs."

What Leibnitz said almost 300 years ago is true today for other graphic symbols. Their advantages are so apparent and the need for them so pressing that they are popping up everywhere. Sets of proposed glyphs are being developed by different international bodies for highways, for railways, for airlines and airports, for machine tools, for hospitals, and for many other products and services. World's fairs and Olympics, too, often develop their own sets of symbols to guide and inform visitors.

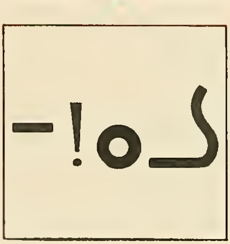
The result has been much experimentation, some progress, and a great deal of confusion. The creation of symbols by organizations with a limited scope of authority (airports, railways, or even a single hospital) causes waste and confusion and threatens us with chaos.

Some international bodies have taken action to channel the many efforts into co-ordinated thinking, research, and development. International design groups have set up a Commission on International Signs and Symbols which works with UNESCO, the International Standards Organization, the International Chamber of Commerce, and others. Out of these efforts, a worldwide set of unambiguous and instant non-linguistic graphic symbols may emerge.

But we are still far from attaining this objective. How far is made apparent by a recent test of the road signs and symbols adopted in Britain. Motorists and pedestrians were separately tested on their ability to recognize "standard" road signs. Only about one-third of all motorists tested could correctly identify a sign that prohibited all motor traffic; only two-thirds could identify a sign that indicated "no passing." Many motorists obviously do not know the signs that directly affect their own safety. Pedestrians (those without a current driver's license) did even more poorly. Only 34 per cent could identify the "no entry" sign and only 18 per cent the sign prohibiting bicycles and motorbikes. The reason is apparently twofold: first, the so-called International Road Signs are very poor in concept and design (they are not in use in the United States), and second, an insufficient effort was made to "teach" the signs before they were introduced.

We can now see more clearly what is needed if the world is to have a set of glyphs that will help travel, trade, safety, and communication in general. We need co-ordinated re-

A Blissymbolics
B International Committee for Breaking the Language Barrier
C Expo 67
D International Air Transport Association



A

B

C

E

F

G

E No Entry
F No Passing
G All Motor Vehicles Prohibited

[otorists and pedestrians in Britain proved in a recent test that many not know the meaning of road signs such as those ve. Women demonstrated ess recognition than men.

search, development, and testing; broad private and public support for glyph development; a nationwide educational campaign as glyphs are introduced into any one country; and a permanent body of international and national experts to keep the international symbol system up to date, effective, and simple. Until we reach that time, all symbol systems currently in use should be thought of as only temporary and subject to replacement.

A Rich Second Language

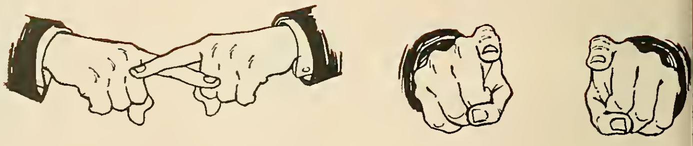
While a universal series of glyphs permits anyone who has learned a very few symbolic devices to move about anywhere, safely, and find comfort and rest, the need for a spoken language, which will enable people from any part of the world to communicate with people from any other part, is of a different order. Here the hope is that we can in some way develop a language in which all the peoples of the earth can really talk with each other, not merely about the business of money, schedules, directions, and rules of the road —which are the problems that can be solved by glyphs—but about events, about politics and religion, about memories of the past and hopes for the future. We need a language that can be spoken to very young children; a language that can be spoken by a woman giving birth in a foreign hospital or by someone having an emergency operation in a strange country; a language in which a psychiatrist can speak to a disoriented foreign sailor; a language through which a professor can find out what is troubling a brilliant foreign graduate student who is doing badly. We need, indeed, a language that runs the gamut of human experience, that is redundant in the extreme because it allows for use by the stupid as well as the bright, by the child, the senile, and the disturbed, by the mother singing her child to sleep and the lover shyly importuning his beloved.

When the first idealists began making up new universal languages on a European base, the difference between a natural language and a carefully constructed, perfectly regular, "easier to learn" artificial language was not yet understood. People believed that one barrier to learning certain languages was that those languages were particularly hard to learn; another barrier was a chauvinistic preference for one language over another. The answer seemed to be to create, using some known set of more generalized grammatical rules, a new language, which, its advocates admitted, people would have to *learn* to speak. But it was not then understood that a natural language differs from an artificial language in features that we do not at the present time have the skill to build into a new language: redundancies, for instance, of sound patterns, cadence, accent, and intonation which in a natural language developed over centuries of use by individuals of different levels of intelligence. Like a human culture—the complete repertoire of learned human behavior characteristic of a society—a language is based in the history of its predecessors. It has been changed through time by the unconscious and inarticulate behav-

is what happens when al groups try to solve blem in glyph creation. of these symbols ars to have much ce of winning the race simple and meaningful h for "No Smoking."

D

Regardless of their language backgrounds, the deaf can communicate through visual signs. Here, uncrossing the fingers expresses "but."



ior of its speakers; and sometimes consciously and articulately by those who have attempted to write rules of grammar and spelling. Because it was shaped by all its users, by those who stammered and stuttered as well as by its orators, it can be learned by any human being who is completely exposed to it.

We know that children easily learn the language spoken around them, even if it seems difficult to the speakers of other languages. Whether adults are able to learn a language the way children do depends on what they have learned about learning languages. about the relative status of the language they speak and that of the language they wish to learn, and upon the intensity of their exposure to the language. Language learning is directly related to intensity of exposure; speaking a language seven hours a day produces learning at an enormously greater rate than taking a lesson a day and then retreating into one's own language. Sometimes a situation arises where a child refuses to learn a second or third language, but this is a question of using language learning symbolically, not a question of the extent to which any language can be learned by any human being, even one of quite low intelligence.

It is necessary to emphasize these facts in the United States because owing to the immigration situation in this country, children were taught to refuse to learn the language spoken by their immigrant parents. This in turn affected the language-learning capacity of those whose ancestors had immigrated much earlier. The dogmatism of our methods of imparting American English—"this is a *glass,* the French word for glass is *verre,* the German word for glass is *Glas,* Spanish is *vaso*"—means that we do not teach children that such nouns are simply the way in which speakers of a particular language refer to phenomena in the outer world, for which other peoples have equally "correct" other names. We teach laborious point for point translation, not a total interrelated system. We have only to compare the difficulty we have in teaching languages in American schools with the ease with which children who are expected to do so learn other languages —as in the Netherlands, for example —to realize that the expectations of teachers, parents, and peers set up conditions of learning or non-learning. We then mistake results produced under these conditions for measures of individual capacity to "learn languages" or for measures of the relative difficulty of particular languages.

If we are to have a global language that all can learn if they wish to communicate with people who speak another language, it must be a natural language, a language that has been spoken for centuries. It must not be presented as a language that will supplant one's mother tongue, but as a *second* language, to be learned by those who speak different languages, so that they can speak to each other.

Anthropologists and other social scientists, linguists, communication specialists, and educators concerned with teaching languages are all beginning to contribute to the discussion of a worldwide language. It was

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rather than "ba

ɔfessor Sol Tax, editor of the inter-
ional journal *Current Anthropol-*
y, who recognized several years
ɔ that the time was ripe to propose
ɪrking on the question: we knew
ough about the nature of language,
out how languages were learned
d could be taught, and we had
e necessary technical equipment—
day enormously refined in elec-
onic recordings and language lab-
atories. At a conference of experts
lled by the Association for a World
ınguage (now the Council on Inter-
ıtional Communications, Inc.). in
965, it was furthermore recognized
at the time was not only ripe, but
at we had reached one of those mo-
ents in history where action was
nperative or the chance could pass
s by. Telestar and its successor com-
unications satellites are the critical
ıventions that make it deeply desir-
ble that people all over the world be
ble to receive the same *spoken* mes-
ıge. The beginning of telecasting in
ne language would provide a real
eason for peoples everywhere to
earn it. But technology will not wait.
ılready there are inventions that will
nable simultaneous broadcasting in
ıve different languages. Once put
nto practice, there will be a great in-
estment in hardware for multilan-
uage broadcasting, bringing into
ılay the linguistic chauvinism and
mperialism of the speakers of the
great languages.

Today, most speakers of English, either as a first or second language, are hotly in favor of English as a worldwide second language. There are two main objections, however, one deep and the other expedient, to taking any great language for a world language. If one of the great languages begins to sweep the world, it will come into competition with other great languages; speakers of these will then attempt to wipe out all the smaller languages within their particular orbits in order to preserve and promote their own languages. Instead of 2,800 different languages, each distinctive and rich with meaning for those who speak it as their mother tongue, we will have a gradual acceptance of a foreign language by millions of speakers of less widely used languages. Human culture will be poorer, and millions of people will be condemned to a kind of secondary citizenship. Forced to function without a true mother tongue, they would risk hearing no lullabies as infants, writing no poetry in adolescence, engaging in no impassioned oratory as young people.

The expedient objection to adopting an existing great language as a world language is political. The non-European world will not, in the present climate of opinion, accept a European language as the second language of the world. This is, we believe, a completely valid objection to the adoption of English, French, Russian, Spanish, etc.

If we are to have a second language rapidly adopted on a world scale, what are its criteria? It should be a natural language. It should be a language that has been written for a long time so that difficulties of orthography have been at least partially solved. It should be easily transliterated into other scripts. It should not be a European language. It should not be the national language of an important political power, a choice that would induce inevitable political rivalry. It should be as slightly as possible identified with one religious or ideological position. There should be a large number of literate speakers who themselves are fluent in the principal languages of the world, so that they would be available as translators and teachers. At the present point of search, Armenian, for example, is a language that meets these criteria.

It may be asked, Why should we take a full-bodied, complicated, rich natural language as a second language to be spoken all over the world? Can we not instead adopt a lingua franca, or at least make whatever language we choose into a lingua franca. Studies of pidgin and creole languages suggest that we should not do so. It is true that those who have learned creole as a second language are in a position of what Alan Lomax has called "communication equity." In the same way, an English-speaking person using New Guinea pidgin to talk to a New Guinea native whose mother tongue is one of that country's some 700 different languages does face the New Guinean as an equal, and this can be accomplished in no other way. But the minute New Guinea peoples abandon their own languages and take up pidgin, as they tend to do, the equity vanishes. Pidgin, or Neo-Melanesian, then becomes the new but impoverished mother tongue of one group, and is therefore foreign to the other. Only a language that all speakers must learn with an equal expenditure of effort and which re-

A circular sweep of the right hand, after first positioning the hands for "advise," signifies the word "influence."

mains a *second* language—neither swallowing up a less influential mother tongue nor being swallowed up or corrupted by the more elaborate language on which it has drawn—can produce and maintain communication equity around the world. Such a second language should, however, have the lingua franca capacity to absorb new words with relatively little alteration, from whatever source, and should have the flexibility that Yiddish displays in different Euro-American settings.

A world second language, like a world system of glyphs, requires universal acceptance to work at all. Until such acceptance, experimentation, temporary solutions, and intensive research are necessary. Casting the die for one language rather than another will be as decisive as putting a new system of mensuration around the world. Failure to do so will be terribly expensive, as failure to adopt the metric system proved to be.

An Invented Language

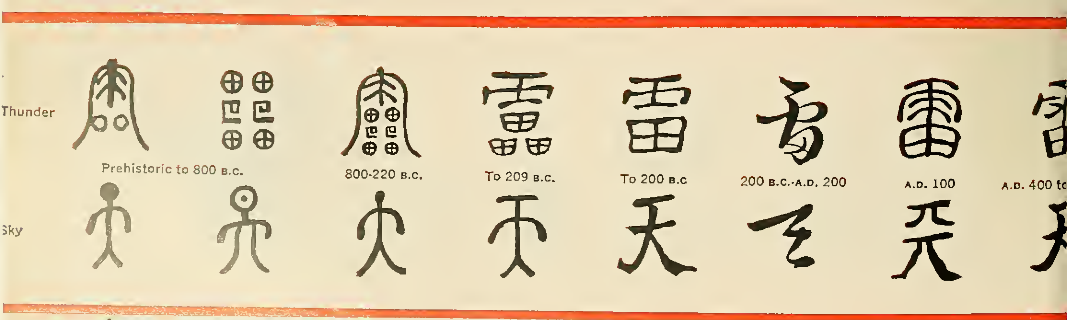
Our third great requirement is for a written form of communication independent of any of the languages of the world, but dependent upon the concepts essential to high-level philosophical, political, and scientific communication. Where the worldwide second language must be natural, formed over time by unconscious human interaction, a worldwide, exclusively *written* language must be artificial, consciously developed, rigorously tested by logic and experimentation. We have, of course, many such partial artificial languages now: in the Arabic numeral system, in chemistry and physics, in engineering diagrams. But the most complete model we have of a written language that is independent of particular languages is the classical Chinese system of writing, through which two educated men, who cannot understand a word the other speaks, may nevertheless communicate fully with each other by writing. The Chinese characters have developed historically. They are not logical and too many of them are needed for full communication; they are heavily laden with the conceptions of Chinese thought acquired from serving 4,000 years of high civilization. A satisfactory system of ideational writing would require a system freed from the accretions of history, although it would not be necessary for the signs themselves to be devoid of historical origins. The contemporary symbols used in biology for male and female were once as heavily laden as a Chinese character: the male is the sign of Jove, the female of Venus; attempts to combine them visually are esthetically unsatisfactory, for there is no logic in the directionality of the two attachments to the circle signifying a human being.

The best model we have for such an ideational language, outside of mathematics and the physical sciences, is that part of the language of the deaf which conveys concepts independently of the words of a particular language, and makes it possible for deaf students from different language backgrounds to communicate with each other. Deaf "signing," to the extent that it uses artificially constructed visual signs, does in action, in face-to-face communication, what a written ideational language could do for speakers of differe
languages.

Various prophetic forerunners c
the future are beginning to exper
ment with such a language. Charle
K. Bliss of Australia has made on
of the most extensive attempts. A
even less abstract attempt was re
ported recently by Jean Effel, a Pari
newspaper correspondent.

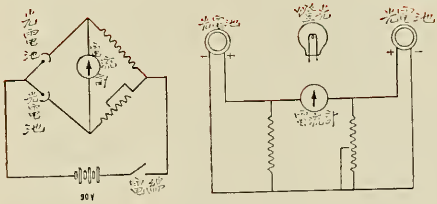
This need is as great as the nee
for a worldwide secondary spoke
language, but it must be recognize
that the steps toward each and th
demands that each must meet ar
almost antithetical. For the spoke
language, we depend upon a natura
historical process. We need a lan
guage that a people has learned with
in the natural human setting, and w
will need to teach it the same way
with maximum exposure and mini
mum initial analysis. For a world
wide, high-level written language fo
efficient communication among th
educated, we must depend through
out on a conscious exercise of man'
most disciplined powers of analysi
and invention, and upon controlle
experiment.

We need glyphs for the child, the neophyte, and the stranger who can neither read nor speak the language of the place he is visiting; we need a worldwide spoken language that will enable people to talk to each other when they travel and to understand broadcasts from anywhere in the world when they are at home; we need a highly abstract, elegant, inductively developed, logical, artificial written language that the educated can read and in which they can write to, and for, each other.

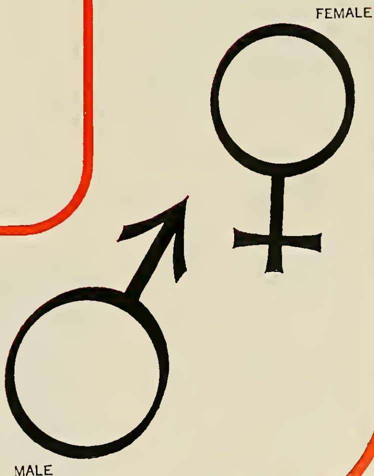


With all three we could take full advantage of our new mobility and share in the kind of relationship once available only on "the village green"; and educated men and women, whatever their mother tongue, could exchange—efficiently and unimpeded by historical nuances—the highest developments of human thought.

There is a further problem that will attend the scientific and humane development of these new world needs. Those who first diagnose a situation have to face great opposition and ridicule, and they develop strongly defensive attitudes. Where there is no hope of success there need be no compromise. Each exponent of each variation in the proposal for a universal language or a new alphabet or a new system of glyphs has tended to be fiercely partisan. Tremendous energies are expended in internecine battles, which in the case of the proposed new languages is said to have once left three of them with only a single advocate each! When the next step is reached, when the dream becomes a reality, a different group of people must take on the tasks and approach them with the appropriate research tools, provided by a knowledge of science, the arts, and politics. This is difficult for the dedicated enthusiasts who have given unappreciated lifetimes to their special causes. It is also expensive for those who now see a chance to introduce a needed change in society. They too may be treated as fanatics, and they will encounter blind and uncompromising partisan opposition from their precursors. How to overcome this dilemma is a social science problem in its own right.



Electrical engineering has evolved simple symbols—for batteries, condensers, etc.— that are now recognized and used internationally.



ucated Chinese who cannot speak each other's nacular tongue can nevertheless "converse" by writing. ch Chinese character carries a heavy burden of torical development, however, and a great many are ded for full expression. Biology's symbols male and female also have historical origins; y do not logically represent the human form.

Daniel Boone is Dead

Continued from page 16

Marie-Antoinette pushing sheep around with a gilded crook."

Not even proficient campers eagerly embrace all the rigors of the wilderness. Those interviewed at Glacier and Quetico-Superior national parks expressed pleasure in being able to cope with primitive surroundings, but their conception of "wilderness" was certainly not Aldo Leopold's. They all wanted to preserve primeval nature, but four out of five also asked for more campsites and amenities. They saw no inconsistency in wanting both. For most of them, Robert Lucas of the Forest Service found, "wilderness subsumes the existence of picnic tables, wells, toilets, washrooms, and the like."

The luxuries of camping are easy to lampoon. "Every time I unpack the folding chromium barbecue pit and the dehydrated soup mix, out there under the stars, I say to myself, 'Gil, boy, this is something you can't escape: it's in your blood.'" All-out primitivism holds little appeal for most Americans. They identify with Huck Finn, who carried as much equipment as possible: a frying pan, a coffeepot, tin cups a knife, fishhooks, and a gun; his raft was made not of logs, but of cut lumber. Hunters in the North Woods may like to identify with hardy eighteenth-century trappers, but bush airlines, lightweight equipment, packaged foods, and bottled gas make modern camping in the far north luxurious. Comfort, sporting operators assert, enhances enjoyment of the wilderness.

"As you grow older," observes a camper, "you learn to tolerate the comforts." Yet discomfort retains a certain cachet. One couple, tired of wet wood, burned pans, and canned rations, realized that they were not pioneers and were pleased about "being honest enough to admit this." They decided to doff their hair shirts and dined in restaurants each evening, but then had to endure the contemptuous disapproval of campers who took nature more seriously. It might not be much of a challenge to survive on packaged food, but a camper ought at least to cook it.

Today a modicum of effort suffices to derive virtue from nature. A redemptive outdoor experience demands no sacrifice of comfort, no great exertion of muscle; it is a voy-

e of the mind, a journey through rests that call less for the woods-ın's lore than for the impresario's ents. The outdoor church at Table ɔck Lake, in the Ozarks, features a blical *son et lumière* entitled "The ıepherd of the Hills." On summer enings in a California national for-t campers sit around a simulated g fire listening to nature lore, atching color movies, and singing d-time ballads. After the perform-ıce, visitors join in the symbolic tual of dousing the campfire, while ngers turn the valve that cuts off the ıs. No embers smolder to cheer the ımper's slumber. Tamed nature has ayed its passive role, and the ıodern Prospero returns home re-eshed, if not exactly reborn.

Every year, however, more and ore Americans come back to the utdoors converted to the wilderness ıystique. From hedonists and heed-ss despoilers they become serious-ıinded amateur ecologists, alive to ıe risks of pollution, angered by the orps of Engineers, sworn enemies f the public utilities and lumber ompanies. And herein lurk new per-s to the landscape. An elite minority ɔday guards treasured wilderness gainst intensive recreational use by ıe unappreciative majority. But the *nlightened* masses will enormously ıultiply the pressure on recreational ınd. No longer content to crowd to-ether in Yosemite and Yellowstone, hey will fan out to all the wilder eaches of the country. Under such n onslaught, the wilderness is apt to lisappear, to be supplanted by fenced ɔreserves and artificial "nature" ıreas for esoteric outdoor studies.

Intensive use by dedicated out-loorsmen already threatens some ıreas. In countrysides that easily ac-commodate individual ramblers, fish-ermen, and hunters, hiking clubs may ɔe anathema; organized recreation is ıpt to endanger or foreclose cove-ıants with landowners allowing ights-of-way across private property. A dozen well-booted hikers as a body ıre more likely to disturb the vegeta-ion and compact the soil of a trail than as many sauntering individual wayfarers. The organized group is also a visual, often an aural, outrage to the resident population, and gives the landscape an unwelcome impres-sion of public ownership. The out-doorsman's environmental needs are thus both special and exclusive; co-existence with residential use is al-

most out of the question. Both his tastes and his impact on the land push him away from lived-in countryside.

It is well to recall that the virtues of the wild were formerly seen in quite another light. Americans used to enjoy the wilderness, if at all, mainly to imagine how much better it would look when the forests were replaced by fruitful fields and teeming towns. Not until the nineteenth century did James Fenimore Cooper and the Hudson River school of painters provide a true wilderness esthetic. Even so, it was the association of wilderness with ruins that endeared it to many Americans. Dead trees were admired as analogues of European architectural relics, and ruined arches were placed up and down the Hudson to enhance the effect of nature.

The Catskills and Adirondacks were later esthetically outclassed by western landscapes, more stupendous and more evocative of human associations. The stratified sedimentary and volcanic rock formations of the West moved visitors profoundly because they reminded them of ruins of great cities, castles, temples, forts, and other monuments of ancient civilization. "One could almost imagine," wrote the geologist Frederick V. Hayden after his Yellowstone expedition of 1871, "that the idea of the Gothic style of architecture had been caught from such carvings of Nature." These architectural qualities made Yellowstone famous and help to account for its tremendous popularity ever since.

It was such curiosities, more than the primeval wilderness, that inspired Congress to consecrate the first national park as a "pleasuring ground for the use and enjoyment of the people." The very word "park" suggests the role originally seen for places like Yellowstone and Yosemite. Both the private landscape parks of the eighteenth century and the urban public parks of the nineteenth were consciously contrived as places for "congregated human life under glorious and necessarily artificial conditions." Park landscapers from "Capability" Brown and Humphry Repton to Andrew Jackson Downing and Frederick Law Olmsted did not aim at imitating, much less preserving, nature but at selecting from and improving on it. Unlike "natural" landscapes, parks were dominated by grassy lawns and groves of big trees free of under-

wth, and often contained orna-
ıtal structures and ruins.

)nly within the past generation our emphasis shifted from the gible enjoyment of spectacular tures, natural or artificial, to a re abstract appreciation of un-ched wilderness. But if intensive causes landscape maintenance blems at the Yellowstone and semite campgrounds, visitor im-t presents potentially graver haz-ls in such areas as Rocky untain National Park, or even Everglades and the Olympics. r from "parklike" to begin with, se fragile ecosystems can hardly vive mass recreation; as Ray smann has said, they may have n better off when nobody cared out them. The overcrowded wil-ness, like the neglected urban k, is the fruit of distinctions in-asingly drawn between wild and ne, natural and artificial, country-e and megalopolis.

'Civics as an art," remarked the neer city planner Patrick Geddes, s to do "not with imagining an im-ssible no-place where all is well, with making the most and the best each and every place, and especial-of the city in which we live." We nnot achieve this by hankering er some distant or exclusive para-e and abandoning all else as be-nd hope. It is not only in the wilder-ss that we escape the tensions of ilized life; man-made environ-nts can also be salubrious. To re-rd everything used as irretrievably oiled is, moreover, to relegate the lderness itself to a museum.

City dwellers have come to believe ture can be found only in un-oiled forests and distant moun-ins. But nature is in fact all around em—in their own backyards and eets, vacant lots and waterfronts. e need to foster an appreciation of ture in all its guises, humanized as ell as wild, near as well as far, inti-ate as well as grand, transplanted well as preserved.

The once-in-a-lifetime wilderness perience, the two-week cross-coun-y jaunt, the Sunday jog around the servoir—these are too rare to sus-in a real appreciation of nature, en when supplemented by sump-ous picture books of primeval eas. The aspects of the outdoors at people care most about are those ith which they are familiar; to ve at a distance is not enough.

Books in Review

The New Ecology

by Peter Farb

A Different Kind of Country, by Raymond F. Dasmann. *The Macmillan Co., $5.95; 276 pp., illus.*

Ecologists are almost our last hope of coping with the modern dilemma: how can we find a better life for the human species without destroying the natural environments upon which this better life depends? It is discouraging, though, to think that we may have pinned our hopes on the wrong people. A typical article in the official journal of the Ecological Society of America recently was "Response of mountain grassland vegetation to clipping in southwestern Montana"—and month after month dozens of such articles, dealing with minutiae, appear in various journals. Clearly, an ecological study of the lawn mower effect in *southwestern* Montana is not very urgent even to people in nearby *northwestern* Montana, much less to the population of the continent at large.

Such a narrow conception of ecology is disheartening, for almost exactly a century has passed since the Germa zoologist Ernst Haeckel named th new science and held out its promis (He derived the name from the Gre *oikos,* meaning "place to live"—and s literally, ecology is the study of livir things in their natural "homes.") Tl original idea of ecology was to tal the building blocks of many disciplin and fashion them into a monument structure, a new concept. But someho along the way ecology stopped erec ing new monuments and began turnin out little building blocks of its ow And, saddest of all, ecologists came t look upon the environment as som marvelously meshed mechanism u touched by the heavy hand of man.

Which is not to say that *all* ecolog has suffered this fate. A relativel small band of ecologists has continue to build monuments to new ideas—an most important, they have put human back into the environment. These pra titioners of the new ecology are con paratively few, but I want to nam some of them so that when you encou

A bird's-eye view of the future. From "A Different Kind of Country."

ter their names in books, articles, even TV and radio programs you will know they are worth paying attention to. They include (with apologies for omissions) Marston Bates, Helmut Buechner, Stanley Cain, Ritchie Calder, LaMont Cole, Barry Commoner, Fraser Darling, Raymond Dasmann, Rene Dubos, Frank Egler, Starker Leopold, Carl Sauer, Paul Sears, and Lee Talbot.

One of the most articulate of them all is Raymond Dasmann, formerly chairman of the natural resources division at Humboldt State College in California and presently co-ordinator of environment studies for The Conservation Foundation in Washington, D.C. His *The Last Horizon* (Macmillan, 1963) was an exceedingly good report on what the new ecology has been concerned with. Near its conclusion, Dasmann warned: "The most alarming single trend on earth today is the trend toward uniformity. It extends through all of life: vegetation, wild animals, human cultures."

Now Dasmann has devoted a whole book, *A Different Kind of Country*, to the theme of diversity, and it will undoubtedly become a minor classic. Diversity is what we are really talking about when we speak of "preservation" or "conservation." The dangers of the trend toward uniformity—"environmental simplification"—can be seen all around us. Forests composed of a diversity of living things have been mowed down, and in their stead neat rows of pines have been planted as far as the eye can see. A forest of many species of trees is not as vulnerable to attack by a disease or insects, but a tree farm consisting of a single species can become a shambles in a season.

The same monotony is descending upon human cultures as well. In Borneo youths listen to the Beatles on transistor radios while waiting to be initiated into pagan rites. On the altiplano of Peru the descendants of the noble Incas watch Disney films. Comments Dasmann: "It will do us little good to conquer nature or even pacify mankind if the world we create is bland and uniform, one where life passes quickly because nothing new can happen again anywhere."

This is one of the most quotable books I have read since Aldo Leopold's *A Sand County Almanac*. Dasmann says a lot of things you or I might not agree with. But we have to listen—not only because Dasmann is eloquent and passionate in his beliefs but also because in the end it will probably turn out that almost everything he says is true. Reading Dasmann can be an unsettling experience. The challenge of his point of view is clear: "In today's world ecology can be an uncomfortable discipline. The questions it will raise

ıy put you out of step with your felw men." Things that most of us have ıg accepted as easy answers (wilderss, preservation, national parks, and forth) turn out, after Dasmann's alysis, to be hard questions. All ɔng we may have been tolerating the tolerable and attacking the trivial.

The book is filled with irreverent ɜws that become truths as we ponder em. Dasmann points out that ecology ıs learned far more about the wild ıimals for whom we build homes in os than it has about the human anial for whom we are now building new ties and suburbs. Let us keep on udying the ecology of Yellowstone, ; says, but let us also study the ecolɟy of Harlem and Watts.

Or listen to Dasmann on the Wilderɜss Act: "Sometimes I wonder if our ıal act of wilderness destruction did ɔt lie in designating formal wilderɜss areas for preservation. In defining ıe boundaries, writing the rules and ublicizing the results, did we not reıove the last magic and make all real.e that the remote and unknown was ow available to all?"

Or Dasmann on the usefulness for ildlife of man's ugly artifacts: "Birds ıow an easygoing attitude toward ɜlephone poles, equating them with :ees. Indeed if we succeed in putting ll electric and telephone lines underround, we will decimate the populaion of kingbirds, swallows, shrikes, parrow hawks, and woodpeckers that ave used these man-made structures ɔ extend their habitat."

Or Dasmann on the fallacy of primiive man as an instinctive preservationst: "It is easy enough to sell Americans on the value of the pieces of vilderness we have left. It is difficult o go to other countries and convince he custodians of the earth's really vild lands of their importance. . . . Noɔody who has not contemplated Hirohima can realize that among the ways ıvailable in which a man can die, it is ı rare and signal distinction to be :illed by a leopard."

Much of humanity's troubles with ts environment can be solved, Dasnann believes, in "planning against ɔrogress." He does not intend that we ;hould all become reactionaries or that we should have peyote dreams of reːrieving a world forever lost. Such ɔlanning is eminently practical, and ırgent. Dasmann emphasizes that we ıow possess a good deal of the sciencific information, and all of the techıology and natural wealth, to start making environments that are acceptable to us and to the living things with which we share the globe. He seeks a possible, not a perfect, world: "The Garden of Eden has been left behind, but here somewhere on the far side of Eden we may yet create a more livable

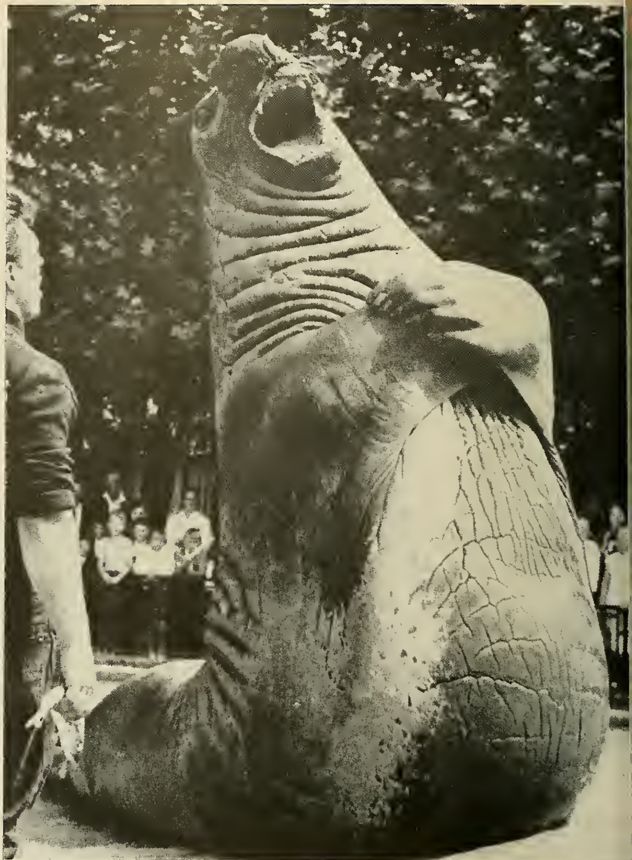
world. We cannot build the perfect world and if we could we would probably tire of it, since we are imperfect beings. We are various in our aspirations and the best we can hope for is a varied world."

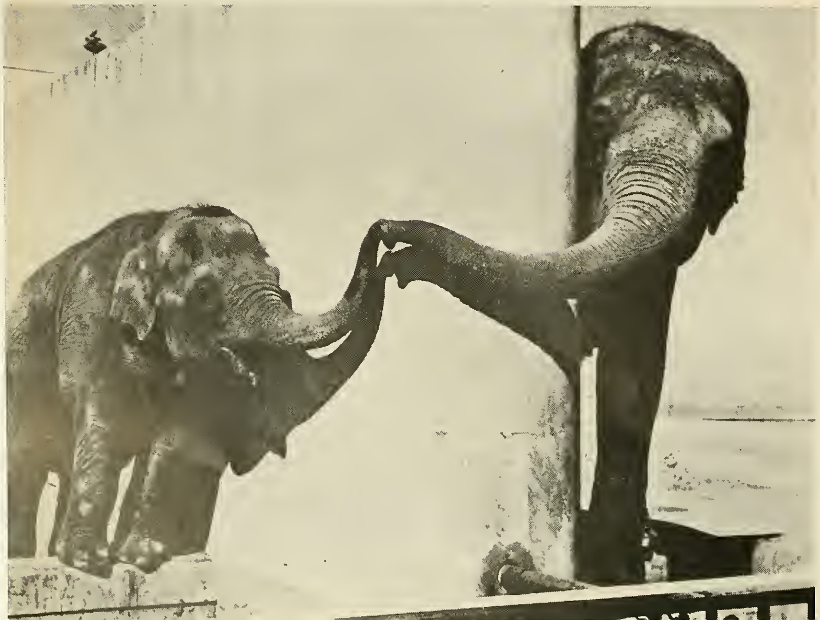
This is an altogether wise book about the human species' clumsy attempts to run this planet of ours.

Peter Farb is author of the forthcoming book "Man's Rise to Civilization as Shown by the Indians of North America from Primeval Times to the Coming of the Industrial State."

THE WORLD OF ZOOS, edited by Rosel Kirchshofer. *The Viking Press, $10.95; 327 pp., illus.*

Zoos annually outdraw all other institutions of culture and all sporting events in attendance. The part of a zoo the visitor sees, however, is the end result of a vast, usually hidden effort by a great many people using science, ingenuity, trial-and-error, patience — and sometimes sheer luck. Half a century ago a leading authority on gorillas declared unhappily, but positively, that it would never be possible to rear a gorilla to maturity in captivity; today the species is represented by healthy adults in almost all major zoos, and captive breeding has begun, thanks to the persistence of zoo men the world over. Some of the complexity of their tasks can be seen in the articles in this book, the first in recent years to be written by men in the profession, rather than by interested laymen. Each of the four-





Although he appears to be singing an aria from Rigoletto, *this elephant seal is only begging for a fish held by his keeper. The young elephant, at left, alone in the enclosure, manages to maintain contact with its mother. From "The World of Zoos."*

ı authors is a European by birth, their experiences are typical of all men.

'he writers give a candid view of a 's operations, and the very human ures of the men who look after the mals. A keeper resists his director's ers to make a change in the diet of animal. A director tells of the letters gets from well-meaning, but gener- misinformed, members of the pub- telling him what he really *should* doing for this or that animal; how must force himself to give a civil swer in cases where "a normal hu- n being would find an appropriate ply" to some of the nastier letters. e newly appointed director of a zoo it is yet to be built is faced with ti-zoo pickets and a midge-swarm of tails he must take care of before the st bulldozer arrives—and to take a th he must first evict from the tub 38 pound snapping turtle too valuable release. One of the world's most spected animal dealers recounts the st changes the last few decades have ought in animal shipments (it may rprise some that air transport is a ixed blessing).

Although the major features of op- ating a zoo are covered, the topics are eated somewhat unevenly. More than hundred pages are devoted to a gazet- er of the world's major zoos, with ex- nsive, but occasionally opinionated, escriptions of the larger ones; this ction will be of less interest to all ut the most confirmed zoo buffs. The ajor essays contain very few factual rrors (two species under my care hen I was a curator are misidentified), ut typographical errors abound, as if roof had been read by someone whose rst language is not English. The vol- me is profusely illustrated with color nd black-and-white photographs that re a welcome addition to the text.

JOSEPH A. DAVIS
New York Zoological Park

MAN AND THE COSMOS; THE NATURE OF SCIENCE TODAY, by Ritchie Calder. *Frederick A. Praeger, $5.50; 219 pp.*

This book is one in the series "Bri- tannica Perspectives," prepared to commemorate the 200th anniversary of the *Encyclopaedia Britannica.* Ritchie Calder is Britannic himself. He was at one time Science Editor of the London *News Chronicle,* and is now a peer of the realm. He has, how- ever, more important qualifications than those to write a book in this se- ries. His own store of knowledge is encyclopedic, and he has a particular talent for popular writing. In fact, he received the 1960 Kalinga Prize for "promotion of the common under- standing of science."

In this book, addressed to the interested public at a time when it is just possible that its interest is beginning to veer away from science, Ritchie Calder discusses in a somewhat historical framework what science is and what it is about. He first defines science as "*present verification* without *ultimate certainty*," and then discusses, in a chapter on the nature of scientific revolutions, how it has developed. He then proceeds to matters of scientific substance as well as attitude. Chapters on scientific subjects are presented topically, rather than in strict chronological sequence. Dimension and relativity, cosmological theories, the origin and nature of stars and planets, are taken up in turn. Considerations of our own planet, the earth, occupy the major part of the book: its envelope, its crust, its core, its seas, its climate.

The nature of matter and the nature of man receive some attention toward the end, but the book concerns itself more with the cosmos of the title than with the man (except as man looks at the cosmos). "The ultimate aim of the scientist," writes Calder, "is to provide a logical explanation and a numerical definition for everything from the egregious behaviour of the latest subatomic particle to the uttermost quasar; to explain the supernatural in explicit terms of the natural (*i.e.* measurable); to reduce the occult to the substantial and, in the process, to account for life itself without recourse to special creation or *élan vital*. Some would say that this is a matter of opinion. The reductionists would say that opinion itself is matter." Life and its continuity with non-life is taken up primarily as related to molecular genetics and other aspects of modern biochemistry. Assiduous or even casual readers of NATURAL HISTORY will know more about organisms than they will find in *Man and the Cosmos*, but they will be well instructed in the physical and earth sciences.

JANE OPPENHEIMER
Bryn Mawr College

SOUTH OF YOSEMITE: SELECTED WRITINGS OF JOHN MUIR, edited by Frederic R. Gunsky. *The Natural History Press, $7.50; 269 pp., illus.*

Having collected the original printings of John Muir's magazine articles, which appeared mainly during the final quarter of the last century, I am gratified to see several of them reissued in this book. Many of these fine essays have found their way into other volumes over the years, for John Muir's writings have long inspired numerous authors and editors. In 1912, Muir published what has been called a "guidebook" to Yosemite National

:. Actually, it was far more than a ebook. In characteristic strong, ly imaginative, poetic yet disci- ɜd prose, it is an unequaled descrip- and interpretation of the magnifi- High Sierra wilderness region.

he editor of this new book has cted wisely from a variety of Muir ce materials—including journal ies, newspaper clippings, and let- —to provide what will probably be ed a guidebook to Kings Canyon Sequoia national parks, which, as title indicates, are south of Yo- ite. Reprinted here in fragmented n are articles that first saw the light day in such publications as *The rland Monthly* in 1874, *Scribner's nthly* in 1878, *Century Magazine*, *rper's Monthly*, and the *Atlantic nthly*. One can give thanks to the tors of these journals who initially ognized Muir's gifts as an author; l brought not only his work but the intry he loved to public attention.

ohn Muir, together with John Bur- ighs, exerted much influence upon eodore Roosevelt in relation to con- vation practices, policies, and phi- ophy. It may be said that Roosevelt ed much of his reputation as a "con- vationist" to these two authors. Bur- ighs with his Hudson Valley nature itings and Muir with his High Sierra scriptions, each, in his own way, in- enced conservation past and present ohn of the east and John of the west.

Citizens who treasure the great na- nal parks of California are in ever- sting debt to John Muir. It was rgely through his efforts that our tion was made aware of the grandeur d unparalleled scenic and scientific lues of the Sierra region and the need r its preservation. Long ago Muir eached, "Save the Redwoods," and any redwood groves were saved for sterity with added ones to come. One the most stimulating accounts pub- shed in *South of Yosemite* is an article uir prepared for *Century Magazine* 1891 entitled, "A Rival of the Yo- mite." This was another of his ap- eals to set aside wild country and rotect it from harmful exploitation. efore submitting this account, Muir rote the editor: ". . . I fear [that this rticle] will be a rough piece of writ- ıg. My stock of cliff & cascade adjec- ves are all used up & I am too dull to ivent new ones. Still it will have a ood deal of topography and timber in & may answer the purpose of a park rgument. . . ." Indeed it did "answer ıe purpose." Complete with maps and ıll-page drawings, it proposed "one rand national park" and concluded, Let our law-givers then make haste efore it is too late to set apart this urpassingly glorious region for the ecreation and well-being of humanity. nd all the world will rise up and call

them blessed." A reading of this well-planned book will serve to explain why modern conservationists also call John Muir "blessed."

WILLIAM H. CARR
Arizona-Sonora Desert Museum

MAN AND THE CALIFORNIA CONDOR, by Ian McMillan. *E. P. Dutton & Co., $5.95; 191 pp., illus.* A PARADISE OF BIRDS, *by Helen Gere Cruickshank. Dodd, Mead & Co., $7.50; 398 pp., illus.*

The basic theme of both these books is that endangered species of birds are nearly always in trouble because of man's ignorance, stupidity, or greed. So far as we know, no species has simply died off since man has been around, but men have completely wiped out a number of species. Among the most seriously endangered today are the California condors and the whooping cranes. Ian McMillan devotes his whole book to the condors. Helen Cruickshank gives a long chapter in her book to the whooping cranes and their Aransas refuge.

The McMillan book probably is the most thorough report ever made on the California condors, which the author has known since his boyhood. It is also a detailed indictment of official neglect and incompetence and of public indifference. McMillan and his brother, Eben, did the field work for the 1965 report on the species published by the National Audubon Society. They are members of a ranching family that has lived in condor country since the 1880's. In the past twenty years the known condor population has fallen from sixty to forty-six, and even that remnant has been saved only by the most vigorous work of a few people and organizations.

The condor range extends from within sight of Los Angeles—their Sespe Sanctuary itself is only twenty miles from the city—northward up the flanks of the San Joaquin Valley. Almost everywhere the birds are threatened by poison, thoughtless or malicious hunters, or bulldozers. McMillan's book states the problems and points out that further encroachment will mean extinction. It also tells in detail about how condors fly, nest, raise their young, what they eat, and how long they live. It is not only first-class natural history but vigorous, crusading conservation.

Helen Cruickshank's book also demands more sensible, more effective protection for rare species. But since she deals with many species that are not endangered, except by the creeping hazards of poisons and pollution that menace every one of us, the impact is not as crushingly emphatic. Actually, hers is an exultant book because it deals with spring in Texas, and the ex-

periences are of many years, not only one. The basic subject is birds, but the whole range of bird, animal, and insect life is noted and often discussed. The Cruickshanks see all kinds of strange sights from their observation blind.

Mrs. Cruickshank has a sense of humor, writes with grace, and has a knack of filling the chinks of her observation with material from library research. The result is excellent, but I wish when she was reading about wild turkeys and the Pilgrims' first Thanksgiving she had checked with Governor Bradford's account. Bradford tells of venison and waterfowl aplenty at that feast, but makes no mention of "fat and succulent roasted turkeys," which some lesser authority must have dreamed up. But the book as a whole is a splendid adventure for any reader; and Allan Cruickshank's photographs, 48 pages of them, are, as always, superb.

HAL BORLAND
Naturalist and Author

GREAT WATERS, by Alister Hardy. *Harper & Row, $10.95; 542 pp., illus.*
HARVEST OF THE SEA, by John Bardach. *Harper & Row, $6.95; 301 pp., illus.*

New books about the sea and its life appear each publishing season, reflecting the mounting interest or avarice of a society feeling the pressures and problems of its expanding population. The sea is wonderfully rich in the diversity and beauty of its living freight, and all who have studied its creatures have opened their eyes in wonder. At the same time, the sea is a source of abundant food that man has exploited for time out of mind. It now seems to offer not only unlimited sustenance but also mineral wealth of great magnitude. The sea is to be farmed for food and mined for everything else. Alister Hardy writes nostalgically, although with immediacy, about the *Discovery* investigations of 1925-1950, described by Robert Cushman Murphy as the greatest undertaking ever carried out in the oceans of the far south.

Hardy's account of the great waters is a vivid, personal story of his years spent as chief zoologist of the *Discovery* enterprise; sailing the wildest ocean of the world, the "roaring forties," or ashore on one or another of the cold islands of the subantarctic ocean. Photographs, drawings, watercolor sketches, and lively, enthusiastic writing make the book a joy to own. The reader is swept along, feeling that he, too, is at sea in one of the sturdiest cockleshells of all time. The ship first used was the original *Discovery*, built for Captain Robert Falcon Scott for his 1903 expedition to the Antarctic

continent; a vessel said by him to be all too ready to roll forty-five degrees one way, forty-three the other, and in some danger of actually being taken aback if turned too much into the wind; built more for coping with ice than for chasing whales. She behaved no better during this later expedition, and, eventually, was replaced by R.R.S. *Discovery II*, a modern ship built and equipped for the real business of investigating the southern ocean's life and waters from surface to floor, primarily in relation to whales and the impact of the whaling industry. Surprisingly, *Great Waters* is the first general account of this major oceanographic undertaking, and we are fortunate that Alister Hardy has lost none of his joy of life in producing this book.

Harvest of the Sea is a very different sort of book. It is an excellent, impersonal survey of diverse fisheries and their biological basis, together with an inclusive account of the various means by which man is now probing far beneath the ocean's surface.

John Bardach writes from the present, looking forward, concerning himself with the exploration of inner space and its promises and limitations in regard to human needs and expectations. He discusses modern technology in relation to harvesting the life of the sea, with forecasts of possible productivity, but concludes that the bounty of the sea will not be the bonanza an exploding human population is looking for. The book ends with a strong plea for the conservation of resources.

N. J. Berrill
Swarthmore College

Briefly noted:

The Pine Barrens, by John McPhee. *Farrar, Straus and Giroux, $4.50; 157 pp., illus.*

New Jersey has the greatest population density of any state of the union. Amid its tangle of turnpikes, factories, and crowded industrial areas, however, John McPhee has uncovered a wilderness area. How it has survived this long or how much longer it can remain untouched is an unanswered question, but anything else you might want to know about the Pine Barrens—650,000 acres of wild land—is covered by the author. At one time a refuge for Tories, smugglers, and Hessian soldiers who deserted from the British Army, the Pine Barrens now supports a small population of "pineys" who scrape together an existence by supplying berries, wood, charcoal—and at Christmas—holly, laurel, and mistletoe to the urban areas of New York and New Jersey. Mr. McPhee's keen ear for local speech and his ability to reproduce the special atmosphere of the Barrens, make this slim volume an outstanding reading experience.

Howling Wolf, by Karen Daniels Peterson. *American West Publishing. Co., $14.00; 64 pp., illus.*

Perhaps one of our most unusual art colonies was the one developed at Fort Marion, Florida, during the years 1875-78. More than seventy Indians from five hostile tribes of the Southern Plains were imprisoned there, and their jailer, Captain Richard Pratt, encouraged them to re-create, in drawings and paintings, the life they had known before their capture. This book is a handsome collection of the work of Howling Wolf, a Cheyenne warrior. Twelve beautiful paintings are reproduced, depicting scenes of war parties, religious ceremonies, social dancing, and courtship. Karen Peterson has provided a biography of Howling Wolf, and an explanation of each picture's cultural and historical background.

C.B.

Letters to the Editors

A Homily on Gold

I have just finished reading your holarly article on ant lions in the arch issue of NATURAL HISTORY ıd should like to point out that erodotus was not entirely mistaken his assertion that ants mine gold. few years ago I published a book ı the various deserts of the world 3obbs-Merrill), and in my chapter ı the Atacama I mention the fact at Wilhelm Goetsch discovered an ıt there that was indeed mining not ıly gold but other minerals. In his ›ok *The Ants* (U. of Mich. Press,)57) he states that this ant (*Dory-yrmex goetschi*) because of the ɛat in the Atacama, burrows deep to the soil and piles the excavated aterial in craters. As the Atacama rich in minerals, the ant often ·ings up to the surface grains of ınd that contain gold, and they ›metimes can be found in the ant ·aters. He also adds that according "a recent newspaper story" miners the mountains of New Mexico use ıt craters to plot the course of veins ›ntaining manganese.

So even if ants in the Atacama, ıd possibly in other deserts as well, ine gold they still prove their su-ɛrior intelligence to man by discard-ıg the gold instead of toiling all day ng in order to get more.

SLATER BROWN
Rockport, Mass.

Head or Figure?

Although I am neither prehistori-ı nor art critic, I wish to hazard an ɔinion concerning the subject of The Oldest Sculptured Head?" NATURAL HISTORY, May, 1968).

The carving is of great interest. /hat first struck me about it was the ɛndition of what I first took to be ıe mouth. The central vertical line ith a depression or dot above it ıight simply be poor artistry or be ıeant to express surprise: O! Think-ıg further about it, I really couldn't ecome convinced that the carving 'as meant to be a head.

What if the "eyes" were actually reasts; the "mouth" the vaginal pening; the "dot" above it the avel? The "mustache"-like diagonal lines above the mouth could then become the edge of the rib cage; the two lines above the eyes might be a neck and the vague half-circle, only partly seen in the photograph, the top of the new and smaller head. (Do I detect a faint face there with dots for eyes and a small highlighted nose? I'd rather not guess on that). The curious sinuous lines at the bottom of the figure might then be bent legs, although they would be out of line with the "body" above.

I realize that a photograph cannot represent the real artifact. However, I believe that my interpretation might give additional interest to the piece, since it would relate it to the early creation of fertility cult figures.

JOHN KOLARS
Associate Professor
The University of Michigan
Ann Arbor, Michigan

Black and White

Is "The White Problem in America" (NATURAL HISTORY, June-July, 1968) what the editorial note says it is: an ". . . attempt to understand racial rioting and violence in America by comparing it with institutionalized violence in African societies"? Then, for heaven's sake, give us some knowledge about institutionalized violence in African societies, of which—as Messrs. Towles and Turnbull doubtless know—there are dozens if not hundreds. We now have only two very general paragraphs on the subject in the entire article, hardly enough on which to base useful comparisons and from which to draw possibly valid conclusions.

Or is "The White Problem in America" a discussion of race relations in the United States and how they can be improved? Then please do explain, in dynamic terms, what the points of conflict are. Is there no way to avert rioting, looting and arson—or are they, perhaps, socially desirable alternatives to a "much greater disaster"? Or, must we simply accept them because they do occur and will occur—like flood and drought? How can we deal with "racial animosity . . . too ingrained

to be uprooted by legislation"? What can or should we do about the Negro who merely wants "to be accepted as a man; not necesarily good or necessarily bad . . ." Is he to be held to the same standards of social conduct as a non-Negro?

I do not take Messrs. Towles and Turnbull to task here for the sheer pleasure of scholarly debate, but because I believe they have done a critically incomplete job in dealing with a highly critical matter. Indeed they are, in my judgment, dealing with the most urgent social matter of our time —the business of moving from where we are now to a place which most of us can more or less agree is a better place. This matter is not a "problem" —Black or White. It is a continuing job of creation in which each of us should, to the best of his ability and means, take part; for Black or White, like it or not, we will move.

We are all in it together.

GERALD E. BURNS
Counsellor at Law
New York, New York

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COVER—Russ Kinne, Photo Researchers
8-9—Thomas Page
27—Institute of Molecular Evolution, University of Miami
31—Robert J. McCauley
32-33—Russ Kinne, Photo Researchers
34—top, National Audubon Society; left, Jeanne White, National Audubon Society; bottom, Margaret Durrance, Photo Researchers
36-37—top, middle, Margaret Durrance, Photo Researchers; bottom, Russ Kinne, Photo Researchers
39—top, James R. Murray, Photo Researchers; bottom, Jerry Cooke, Photo Researchers
40-47—George Tice
49—Helmut Wimmer
51-54—Don Valentine
56-63—AMNH
68—R. J. Wagner, Soil Conservation Service, USDA
74—Viking Press

Suggested Additional Reading

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handful of people like Mary Carnwath
e trying to keep our promise to the Indians.
ut they won't make it without you.

The Hopi Indians' village of aulovi in Arizona sits on land oor, infertile and inhospitable so far nobody has tried to take ay from them.

Electricity has not yet reached Hopis. Water must be hauled three miles away. Jobs are few far away. Only poverty and des- are close-by and in abundance.

Yet for the first time in genera- s, Mary Carnwath and people her are stirring hope among the is.

Mary Carnwath works and s two thousand miles away, in nhattan. Her own daughter is grown-up, and through *Save Children Federation* she is spon- ng one of the village girls, 8-year- Grace Mahtewa.

The Mahtewas (two parents, ee children, one grandmother a sister-in-law) live tightly ked in a tiny rock and mud se. The father who knows ranch k but can't find any most of the r, isn't able to provide the family even the bare necessities.

Grace, bright, ambitious and industrious, would possibly have had to quit school as soon as she was old enough to do a day's work. But, because of Mary nwath, that won't be necessary.

The $15.00 a month contrib- d by Mary Carnwath is provid- a remarkable number of things Grace and her family.

Grace will have a chance to con- ue schooling. The family has n able to make its home a little re livable. And with the money over, together with funds from er sponsors, the village has been to renovate a dilapidated build- for use as a village center. The ter now has two manual sewing chines that are the beginnings of mall income-producing business. only a small beginning. More ney and more people like Mary rnwath are needed. With your p, perhaps this village program will produce enough money to end the Hopi's need for help. That is what Save the Children is all about.

Although contributions are deductible, it's not a charity. The aim is not merely to buy one child a few hot meals, a warm coat and a new pair of shoes. Instead, your contribution is used to give the child, the family and the village a little boost that may be all they need to start helping themselves.

Sponsors are desperately needed for other American Indian children —who suffer the highest disease rate and who look forward to the shortest life span of any American group.

As a sponsor you will receive a photo of the child, regular reports on his progress and, if you wish, a chance to correspond with him and his family.

Mary Carnwath knows that she can't save the world for $15.00 a month. Only a small corner of it. But, maybe that is the way to save the world. If there are enough Mary Carnwaths. How about you?

Save the Children Federation is registered with the U.S. State Department Advisory Committee on Voluntary Foreign Aid, and a member of the International Union of Child Welfare. Financial statements and annual reports are available on request.

Save The Children Federation—
Founded in 1932
National Sponsors (partial list):
Andy Griffith, Gene Kelly, Mrs. Eli Lilly, Paul Newman, Mrs. J. C. Penney, Frank Sinatra, Mrs. Earl Warren

Save The Children Federation
NORWALK, CONNECTICUT 06852

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☐ $90 SEMI-ANNUALLY ☐ $180 ANNUALLY

I CAN'T SPONSOR A CHILD, BUT I'D LIKE TO HELP.
ENCLOSED IS A CONTRIBUTION OF $________

☐ SEND ME MORE INFORMATION.

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The account of the life and death of Dago'om is the product of PAUL BOHANNAN's many experiences among the Tiv of central Nigeria. From 1949 to 1953 he and his wife, Laura, spent twenty-six months living with this tribe. Dr. Bohannan has also studied the life of the Wanga of Kenya. Currently a Professor of Anthropology at Northwestern University, he is the author of two books, *Africa and the Africans* and *Social Anthropology*, as well as numerous articles and papers.

Author of "The Biological Muse," PHILIP C. RITTERBUSH is Director of Academic Programs at the Smithsonian Institution in Washington, D.C. At Oxford, he studied the history of science as a Rhodes scholar. He has published two books. The first dealt with the speculations of eighteenth-century naturalists and the second. *The Art of Organic Forms*, published last month by the Smithsonian Institution, forms the basis for Mr. Ritterbush's article, and was produced in conjunction with an exhibit of the same title at the Smithsonian.

PETER FARB, whom Secretary of the Interior Stewart Udall once described as "a young man with a consuming interest in the land and living things," is a recognized authority on the human and animal life of our continent. He has written several books, among them *Face of North America* and *Land and Wildlife of North America*. For several years he has been a consultant to the Smithsonian Institution, as well as Curator of American Indian Culture at Riverside Museum in New York City. His contribution to this issue is excerpted from his new book on North American Indians, soon to be published by E. P. Dutton & Co., Inc.

FRED BREUMMER, a free-lance writer and photographer, has contributed the article on polar bears in this issue. His work has appeared in magazines all over the world, including NATURAL HISTORY (August-September, 1967, and March, 1968). He has traveled in Europe, Africa, and the Middle East, but is best-known for his accounts of Canadian Arctic wildlife. He has, among other things, traveled some 1,200 miles by dog sled in the company of Eskimos and studied muskoxen on Spitsbergen, an island group belongin to Norway.

EDWARD O. WILSON, collaborato with THOMAS EISNER on the story o Lignumvitae Key, is a Professor o Zoology at Harvard University an an authority on the behavior of so cial insects. Through his travels i New Caledonia, New Guinea, an other far-flung areas, he has adde rare specimens to Harvard's Museun of Comparative Zoology. He has als contributed to basic research on th fire ant, a current threat to souther U.S. agriculture. He was a Junio Fellow in Harvard's Society of Fel lows, and is a member of the Amer ican Academy of Arts and Sciences

THOMAS EISNER is not only a biolo gist but also an enthusiastic pianis and harpsichordist. Professionally his main interest is in what he terms "the chemical language of animals." Dr. Eisner is a Professor of Biolog at Cornell University and a forme Guggenheim Fellow. He is widel traveled, and has written one boo and more than seventy articles, half-dozen of which have appeare in NATURAL HISTORY. His most re cent contribution, "Life on the Stick Sundew," was published in the June July, 1967, issue.

DAVID K. and MELBA C. CALD WELL, authors of NATURAL HISTORY's second dolphin article (*see* June July, 1968) are among the country's leading experts on cetacean biology Dr. Caldwell is Director of the Marineland Research Laborator (Florida), where he and his wife ar carrying on their experiments wit dolphins. The author of more tha one hundred papers on the biolog and behavior of marine vertebrates he previously was Curator of Ichthy ology and Marine Mammals at th Los Angeles County Museum of Nat ural History where he directed re search on cetacean behavior. Mrs Caldwell is Associate Director of th Marineland Research Laboratory She formerly supervised projects re lated to Antarctic marine biology a the University of Southern Califor nia. Together, the Caldwells main tain an extensive library of publishe material on whales and whaling.

A Man Apart by Paul Bohannan

Dago'om danced into the compound about noon one day in the middle of August, during the break in the rains that the administrative officers and missionaries called the "little dry." Onto his goatskin bag, colored a brilliant orange with dye from the stalks of guinea corn and then worn brown by use and dirt, Dago'om had hung tassels of raffia, bits of coconut shell, and two small calabash-gourd bottles. Dangling among these things was a small monkey skull, about the size of a lemon. It lacked the desiccated, bleached quality of bone, but shone with a brown patina, like ivory that has been in constant contact with sweat and sun. The tiny skull, hanging among the tassels of raffia reminded me of a shrunken head from Ecuador that I had once seen in the Pitt-Rivers Museum.

Like all Tiv, a people of central Nigeria, Dago'om danced with his knees bent. Like all Tiv, he also invented gestures and steps. Dago'om's most successful ploy was to lean over forward, knees bent and far apart; then to flip his buttocks upward so that his large potbelly seemed to slip down between his knees. It was almost as funny as he meant it to be.

He danced forward, seeming to tack against the wind—first to one diagonal and then to the other. Each change of direction was signaled by his own special belly-slip. His heavily calloused feet stamped and shuffled in the dust of the compound—each heavy step seemed to thrust him farther into the earth. But then he raised his right hand—as thick and heavy as his feet—and turned a delicate movement with his wrist. The flick im-

I came later to understand why Dago'om's life might have been dominated by hate

parted grace to Dago'om's movements; the clumsiness and heaviness were those of a clown, not a dunce. The skill of the movement made the shape of his body irrelevant. He maintained one rhythm with his feet, a counterrhythm with his hands and arms, and still another with his trunk. The whole was nevertheless a unity.

His trick of keeping his eyes almost closed produced the effect of a veil drawn between himself and the world, making any contact save laughter difficult. And, after the first few times, even the laughter—mine included—had a cold touch of terror in it. Yet, we always laughed. But I looked away whenever the absurd, toothy grin spread over his face, lifted upward on his squat, sinewy neck. Dago'om was funny, but our laughter was overdetermined. Yet it was the only contact possible. He would not allow any other. If you didn't laugh, you would be engulfed in uncharted and unpredictable confusion—and, for some odd reason, hatred. I came later to understand why Dago'om's life might have been dominated by hate.

He knew only one song: "M gema hundu ve; m gema hundu ve; m ma msolom yum; m gema hundu ve." As he sang it, the song meant, "I am very drunk; I am very drunk; I drank a lot of beer and I am very drunk." He often did drink a lot of beer.

There is an irony in the song: it is in the word *hundu*. In the Tiv language, it means both drunk and mad.

The body of a Tiv tribesman is removed from the place of death in typical burial preparation.

Tiv told me that drunkeness and madness are the same thing—but there is the difference that from too much drink you only get the "little madness" that you can sleep off. But that is getting ahead of the story.

On September 10th, Dago'om returned from a beer party in Yengev. When I heard that he was *ihundu* I was not surprised. But it took until the next day for me to realize that he was mad as well. Once the true meaning of the word sank in, I turned back in my memory (for such things seldom get into anthropologists' notes) to see whether I could remember any symptoms or clues. I recalled that one evening, he and Anwase, both a little drunk, had taken turns doing solo dances in the middle of the compound. The sun had broken through after a rain, and everyone came outside into the brilliant orange light that is never seen anywhere except at dusk in West Africa. Dago'om never let Anwase finish a dance, but kept rushing at him and playfully "killing" him with his heavy clown's hand. Anwase was a trim, light man who moved with grace; it was a pleasure to watch him even as he walked across the compound. He danced with the sad lightness of a jester, and I remembered being disappointed that, as Dago'om had demanded the center of the stage, Anwase had always easily and smilingly allowed him to have it. But this event provided no hint of madness.

I also remembered, with a stroke or two of conscience, that Dago'om made a nuisance of himself sometimes, and that I had more than once shut the door of my hut to keep him from disturbing me. His clowning

had a monotony that I found tediou or worse when I was alone with hir When all of us were together, an when my hosts and my servants wer there to laugh at him, I found hir funny too. Now, I realized that like everyone else, avoided bein alone with Dago'om—nobody coul bear laughing at him except wit the reinforcement of crowds. Alon Dago'om made me uncomfortabl His clowning called up my pity, ur mixed with the wry absurdity th I obviously got from the other Dago'om had always been kind an thoughtful. He often brought m eggs, which were difficult to buy her in northern Tivland. I repaid hi with cigarettes. He once gave me duck, with great mock ceremony.

The night before he went to th beer drink in Yengev, he came to ou compound, bringing his wife wit him. There were a couple of sma pots of beer in our compound, an Dago'om came for a foretaste of wh he was to drink the next day. H forced his frightened and ove dressed, but rather pretty, wife t bring a calabash of beer across th compound and give it to me. She wo a bright orange piece of Mancheste cloth and a man's undershirt (of th sort the British call vests) with whi knee socks and tennis shoes. On he head was a stylishly tied cloth. He face was smeared with face pov der, imported (in Caucasian shades from Britain. She seemed partic larly subdued for a Tiv woman. later learned from her friends th she became frightened when Dago om made her dress up and go wit him to beer drinks; when I talked t her in her own surroundings, an when I adjusted to her normal soci situations, she was not afraid.

I accepted the beer from her wit both my outstretched hands an thanked her. I tasted it and sent it int the kitchen for my servants. Dago'o stormed over. called for a chair, an insisted that his wife sit down o posite me. For a Tiv woman, this a completely artificial situation. F her, it was terrifying, as well strange. I thought then that she wa afraid of me—but I now think th was not so. She was afraid of hi When I tried to talk to her, she r mained dumb. When I tried to ta to Dago'om or to one of the oth dozen people standing or sittin about, Dago'om in a loud voice r

ted to her everything that I had
l. I was uncomfortable enough
t after about fifteen minutes I ex-
ed myself and went into my hut. I
ıldn't take it. I did not know why
had come or what he wanted—
ther did he.
The next morning his wife went
h him to the beer drink in Yengev.
one else from our compound, or
m his, was present. Later I talked
h her several times, but she did
disclose much about what he did
re. She said, in a tight, closed
ce, that he had got drunk from
r, and that after he stopped drink-
; he became more and more
ndu, and it never left him.
She brought him back, God knows
w, as far as our compound. Gu,
host, helped her handle him after
ir arrival but he refused to go the
t of the way back to Asanyi's com-
und, where he lived. It was just
ghtfall, and he was ranting and
outing. When she tried to get him
go home, he loudly screamed
eats at her—that he would beat her
kill her if she mentioned it again.
e retired to a nearby hut, while
ıwase and two younger men took
er. With gentleness and patience
y finally got Dago'om to sleep in
um's hut. The next morning, at
wn, Dago'om was unconscious.
ıwase and one of his brothers made
stretcher from an old *chado* cloth
d two saplings and carried him
me, but I knew little about this at
time.
I did know that Dago'om was in our
mpound and that he was *ihundu*,
t he avoided me. I bumped into
m only once. When he saw me, he
l to his knees and started to sing,
M gema hundu ve . . ." but he never
ished it. With a wild shout, he
unced high and was off in the other
rection. I noted to myself that the
er drink in Yengev must have been
ry successful indeed. Later,
ıwase told me that he was asleep
Abum's hut.
When Anwase returned, he told me
direct imitation, by reference to
nadman in the next lineage area to
ırs, and by references to the sprites
death, which sometimes bring mad-
ss, that Dago'om was mad instead
merely drunk. Dago'om had told
this himself: "M gema hundu ve,"
aning not merely "I am drunk,"
t "I have turned mad"; the way he
d jumped into the air and run

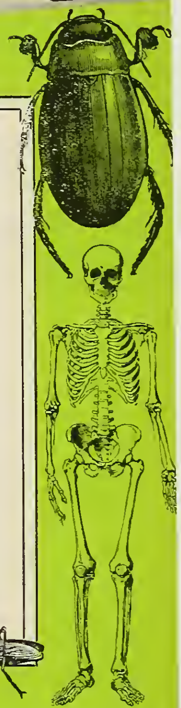
away screaming was his metaph

The day after Dago'om was carri home, I walked the half-mile to s him. He caught sight of me as I e tered Asanyi's compound and bolt in the other direction. I talked abo him with Nege and Abu. Abu claim to have the same father as Dago'o but a different mother. I was soon learn that Abu's father was Dag om's maternal grandfather and th Dago'om had no father.

Nege, a sensible and patient ma was a little more distantly related Dago'om. He told me Dago'om h attacked several people earlier th day, and had mauled one girl wh he picked up a stick and started la ing about him. He had then run in the bush when he saw me coming Nege said it was unlike him, becau Dago'om liked me—and this prov again that he was obviously ma Abu opened his one eye widely a said that they would have to put hi into stocks. Abu had a way of hove ing rather than projecting his wor as he spoke. He stood closer to n face than most Tiv. I was tempt to stand back (a feeling I associa with France, not Africa).

It was four days before I got ba to see Dago'om again. I came into t compound and found him in stock He sat on the bare ground—a deep i sult for Tiv, used in court as a sy bol of a degraded and suppliant co dition. One foot was stretched befo him, inserted through a hole that h been gouged through one end of heavy log of prosopis, a hardwo tree related to mesquite. A seco hole had been drilled at right angl to the first. After his foot had be inserted through the large hol wooden pegs were driven into t smaller hole so that he could mo his foot comfortably, but could n remove it. The log was about eig feet long; a rope had been tied fro the far end of the log to one of t overhanging branches of a venerab fig tree that grew in the middle of t compound. Dago'om could not rea the other end of the log to untie t rope; neither could he stand up untie it from the branch, only couple of feet above his head as sat. The skin of his foot looked d and dead contrasted to the brillia orange of the newly cut prosop wood. His other leg was doubl back under him.

Dago'om had the look of deat



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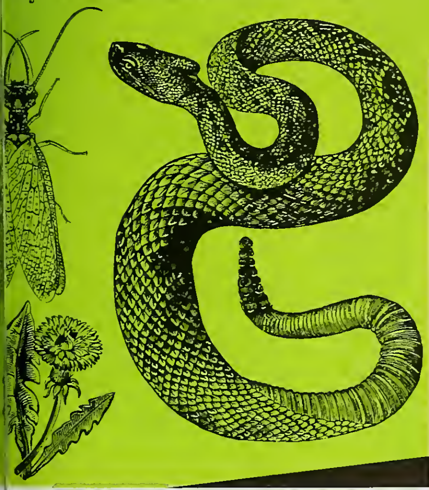

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is smooth brown body was covered y a gray film. There is a vivid Tiv ietaphor for dying: "He is sloughing is skin." using the same word as for snake. Surprisingly, his scrotum ad swollen to the size of a dinner late. Scrotal hydroceles and scrotal ephantiasis are common among iv, but they do not develop sudenly. It is one of the many times that wished anthropologists had some iedical training. Dago'om's eyes ere held broad open, and it was impossible, looking into them, to deteriine where the pupil began. Even ver the whites of his eyes, there emed to be a thin, dimming film.

He recognized me, and said my ame twice. But that was all I could nderstand of what he tried earnestly) tell me. We were alone, and there as nobody for me to ask. In the iinutes of complete concentration, I elt keenly that he was trying to get irough to me, to tell me something and that I was trying as hard and as nsuccessfully to understand him.

As I walked home along the bush ath, which had been newly hoed and idened that morning, it occurred to ie that Dago'om had entered the nal phase of sleeping sickness. robably he had had it all along, and I had been trained to see it, perаps I could have taken him to a hosital and stopped the progress of the isease. It could have been avoided r halted with pentamidine injecons; although I knew that pentamiine was not a part of Tiv culture and iat Dago'om lived twenty-five miles om a dispensary. I knew that I ould not have convinced Dago'om) take the trip to get the injections. ven if I had known what his illness as. Yet, had I been able to give them) him on the spot, he probably would ave taken them. I became aware of n intense sense of guilt—a habit mong those brought up as Protesnts when they look on suffering.

My reaction to this situation was) do something. For me, the most xhausting part of Dago'om's illness nd death was my struggle with the ict that nobody did anything. Alıough I had seen many mental paents, I had never before known one oth before and after the onset of his iadness. There was no change in)ago'om's personality—only in his ehavior. The madness had been in im all along. Dago'om got worse ith his disease and his terror. I be-

came more depressed with that mos
despicable of situations—pity with
out being able to act.

I found that no one had know
Dago'om well. Certainly I had no
No anthropologist ever gets to kno
more than half a dozen of his inform
ants with anything that can correctl
be called intimacy. Intimacy is diff
cult enough with people who are lik
you. Across cultural barriers it in
volves accepting even more thing
about the other person that are nc
part of all that one admires. Dago'or
had amused me, and I had allowe
myself to be amused so that I woul
not have to do anything. I wa
amused at his poor clowning so tha
I would not have to pity him—at tha
time, I still believed I must not pit
people from other cultures becaus
that would be ethnocentric.

During the next few days, knowin
that Dago'om was going to die,
tried to get some information abou
him so that I could better understan
what would be said when all of hi
kinsmen met at his funeral to discus
who had killed him. and how. I as
sumed that Dago'om would be give
the funeral of an ordinary adult male
I had seen a number of them an
thought I knew what would happen
all the disputes among his kinsme
would have to be aired. Then th
"fault" would have to be determined
That is done by a post-mortem opera
tion in which the heart is examine
for a substance called *tsav*. If th
dead person's heart shows the sacs o
blood in the pericardium that Tiv as
sociate with *tsav*, and all supernatura
or unusual ability, then that perso
was guilty of his own death. If th
chest is empty, as they put it, then th
killer is still at large in the com
munity. Tiv never merely die fron
natural causes—to natural cause
must be added an evil volition to se
those causes in motion. And the voli
tion comes only from close kinsmen

I soon discovered that Asanyi, th
head of the compound in whicl
Dago'om lived, was gone. When
tried to find out where he had gone
I was told by one person that he hac
had a dispute about a wife in a lin
eage to the northwest of us; anothe
person told me that he had gone t
Makurdi to sell some crops: stil
another said there was a matter of a
marriage ward—one of his half-sis

Continued on page 6

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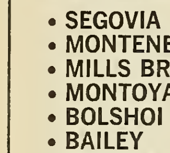

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A Naturalist at Large

Crowded People

Marston Bates

In the August-September issue of this magazine I reviewed some of the work that has been done on the effects of crowding on animal behavior. It appears that crowding is often associated with weird behavior —the suicidal migrations of lemmings and locusts, the "behavioral sinks" formed by the rats studied by John Calhoun. What happens to people when they are crowded?

There is plenty of chance for observation, and opportunities for the study of crowding are increasing steadily. The usual present estimate for the population of the world is 3½ billion persons, and the numbers are now increasing at a rate of 2 per cent a year. This means an annual increase of 70 million: the equivalent of a new Chicago metropolitan area every month. Whatever one thinks of Chicago, this seems a little excessive.

Further, there is a tendency almost everywhere for these growing numbers of people to aggregate more and more in cities. This is true of Asia and Africa as well as of industrialized Europe and North America. If the 200 million people of the United States were scattered evenly over the landscape, the density would be 50 persons per square mile. But 70 per cent of this population lives in urban centers. New York City proper has a density of 25,000 persons per square mile—90,000 per square mile on Manhattan Island. Lewis Herber, in his book *Crisis in Our Cities*, calculates that in the residential parts of Manhattan the actual density is 380,000 people per square mile or 136 individuals for every 100-by-100-foot lot. This is achieved, of course, by stacking the residential units.

Here surely are appropriate conditions for the formation of behavioral sinks, and the rioting and violence of the ghettos would seem to demonstrate that people and rats do act much alike. I doubt, however, that the miseries of the ghetto are purely a consequence of crowding. After all, thousands of men can be crowded on a battleship with no obvious damage to behavior, and conditions in a submarine are even more restrictive. To be sure, the men on a submarine are carefully selected for personality traits; the situation might be very different if the crowded ships included families instead of just men.

There are few detailed studies of the psychological effects of crowding on people. The most thorough and best-known is a three-volume report on an intensive study of the inhabitants of midtown Manhattan by a team of social scientists, entitled *Mental Health in the Metropolis*. The area covered did not include ghettos, although conditions did range from near-slum to luxury apartments. Only 18.5 per cent of the 1,660 people interviewed were found to be free of all but inconsequential symptoms of mental illness. All the rest had some kind of neurotic or psychotic symptoms, although only 2.7 per cent were incapacitated. No hospitalized people were included in the sampling. However, a survey of the hospitals and clinics in the region showed that on an average day eight individuals per thousand were receiving outpatient psychiatric care, and five per thousand were hospital-

The Dull Boy Who Became A Prodigy

• In 1799, an obscure Austrian clergyman, Karl Witte, told a group of skeptical friends: "If God grant me a son, I shall educate him to be a superior man — without knowing what his aptitudes may be."

• Soon, a son was born but showed little promise. The boy's own mother thought him dull. Yet by the time young Karl was six, his father's efforts seemed to be working. At age 9, he entered the University of Leipzig. At 14, he received his Ph.D.; at 23, he became a Professor and went on to a long and brilliant career.

• In Ireland, a man named Thompson heard of Witte's methods and applied them to his own sons. One became a celebrated engineer; the other became one of the world's great physicists, Lord Kelvin.

• Early in this century, Leo Wiener — rummaging in the back of a New England library — found a German book describing Witte's methods. He, too, applied them to a young son. The result: Norbert Wiener — one of the greatest mathematicians of all time, sometimes known as "the father of Automation."

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WAYNE MILLER

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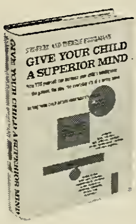

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ized. None of this sounds very healthy.

It is difficult to measure mental health because there are so many differences of opinion among psychiatrists and clinical psychologists. Physical health is easier to measure and compare, and here there is no question about the relatively greater risk to health from living in the city, despite the greater availability of medical services there. Lewis Herber, in the book mentioned above, has reviewed a number of studies. Peptic ulcers and coronary attacks are understandably more common in the city and probably have psychosomatic aspects. Lung cancer among non-smokers is eleven times more common in an urban environment than in a rural one—smokers, on the other hand, have about the same rate in both environments. Lung cancer can be explained by air pollution; but curiously, most kinds of cancer are more common in the city than in the country, which makes one wonder whether some element of stress is involved.

Reading about urban conditions one begins to wonder why anyone lives in cities. There is, of course, a tremendous out-migration to the suburbs by people who can afford it, but this is more than balanced numerically by the in-migration from villages, towns, and countryside. These are mostly people at poverty level coming to the city because that is where the jobs are, now that agriculture has become so completely mechanized. Often there are no jobs, or only jobs with inadequate pay; the resulting poverty leads to the deterioration of the inner city, which has lately been causing so much concern.

We have a national conviction that the city is a poor place to raise children. In the midtown Manhattan study, residents were asked, "For growing children, do you think it is better to be brought up on a farm, in a small town, in a small city, or in a big city like New York?" In reply, only 15 per cent preferred a big city like New York. Interestingly enough, native New Yorkers disapproved of their city as an environment for children just as much as parents who had come in from outside. When asked the same question with regard to themselves, about half thought they would be better off away from New York. Yet millions of people continue to live in New York—and to raise families there.

The middle-class parents of midtown Manhattan tend to restrict the size of their families—a large proportion of the couples having only one child or none. In the slums, on the other hand, breeding seems to be unrestricted. In the racist climate that prevails in the United States, Negroes may even resent birth-control propaganda as aimed at restricting their numbers discriminatorily. Urban middle-class couples are thoroughly caught in the rat race of working their way up in the social and economic systems, so that children become a handicap, while many of the slum inhabitants have given up. Perhaps the competitive struggle, rather than the crowding, accounts for the poor mental health of urban white-collar workers. In the case of the slums, the deprived environment can be used to explain almost anything, including mass hysteria.

I have been writing mostly about the dismal aspects of the crowded city, yet all through history cities have been the habitat of civilized man, the source of progress in the arts and sciences as well as in industry and commerce. There is something exhilarating about life in a great city, some spirit that compensates for the trials of crowding. Besides, people like crowds. Most people go where other people are—packing beaches, parks, theaters, sidewalks. David Lowenthal documented this nicely in the article entitled "Daniel Boone is Dead" in the last issue of this magazine.

The great value of the city lies in its diversity: all kinds of people with all kinds of facilities for filling their varying needs. The very concentration of people provides audiences for the theater, visitors for museums and galleries, readers for books and periodicals, and a market for an immense variety of shops. In the small town, where everyone knows all about everyone else, the pressures for conformity are great. The eccentric, the deviant, the talented, move to the city where they can find more of their own kind. The city is a haven for the artist as well as for the thief.

Cities became possible back about 000 B.C. with the discovery of meth- ds of transporting and storing oodstuff, so that an agricultural sur- lus produced by farmers could be sed to support other kinds of people -priests, kings, soldiers, smiths, hilosophers. The proliferation of ccupational niches in the city has ontinued all through history, and is oing on in our own day at an ac- elerating rate. I suspect that this nultiplicity of niches is what enables eople to survive under crowded con- itions—conditions that rats could ot tolerate. After all, rats lack the neans of avoiding the stress of fre- uent contact between individuals hat occupational diversity provides.

This is the argument of the Chi- ago sociologist Nathan Keyfitz in an rticle in the issue of *BioScience* for December, 1966. "If the city is, on he one side, a jungle of potentially nfinite and destroying competition, n the other it shows a nearly infinite apacity of its members to differenti- te themselves, to become useful to ne another, to become needed."

In psychological jargon, the niche ives a feeling of identity. We are ngineers, teachers, cab-drivers, hysicians, or what have you. We hus belong to a group; but within ach group there are numerous sub- roups reflecting the specialized nowledge or skill of each of us. As Keyfitz points out, there may be a nundred specialties within such a ield as electronic engineering—the ossible specializations within a mod- rn city are truly almost infinite. Also, there are almost endless organ- zations within the city, sometimes competing, as banks or stores: some- imes providing general service, as he educational or telephone systems. These organizations further pattern pace in the city and serve also to re- luce stressful contacts among indi- viduals.

The man in the city comes in con- act with hundreds of other people every day, but most of these con- acts, unlike those between crowded ats, are not stressful. We are not nvolved in the private life of the cab-driver, the bank clerk, or the re- porter for *The New York Times*. We usually know little about our physi- cian or lawyer beyond confidence in his professional skill. As we move be-

tween the small world of home and the small world of the office or business place, we pass many hundreds of people, but for the most part this results in no meaningful relationships. We are inured to other people.

This kind of individual support is generally lacking in the ghetto, which is probably one of the causes of ghetto unrest. The unemployed or the underemployed person becomes Ralph Ellison's "invisible man," uncertain about work, not knowing how to get money for rent or groceries or the installment on the television set. Ghetto life has been graphically described in the Kerner report on riots, and in books like the novels of James Baldwin and the report on the life of Puerto Ricans in the United States by Oscar Lewis. Prostitution, alcoholism, drug addiction, and violence become rife. The Kerner report found that 42 per cent of Negro families with incomes of under $3,000 had no father living at home. The ghetto world is in large part a matriarchy—with mother constantly distracted by the problems of survival. The ghetto thus comes to resemble the behavioral sink of Calhoun's rats, except that it continues to reproduce.

Poverty tends to shackle us, and wealth to free us, without much relation to the intensity of crowdedness. This makes me wonder about that "territorial imperative" of Robert Ardrey and others. If the human species is strongly territorial, how did the formation of cities ever get started? I share with Ardrey, Lorenz, and others the feeling that Old Stone Age man lived in social groups, with individuals within the group forming a dominance hierarchy or peck order and with the whole group occupying a defended territory. But I suspect that with the beginning of settled life and agriculture during the Neolithic, territoriality started to break down. Cities, city-states, and empires—with their wars and rebellions—represent cultural ideas, rather than territorial instinct.

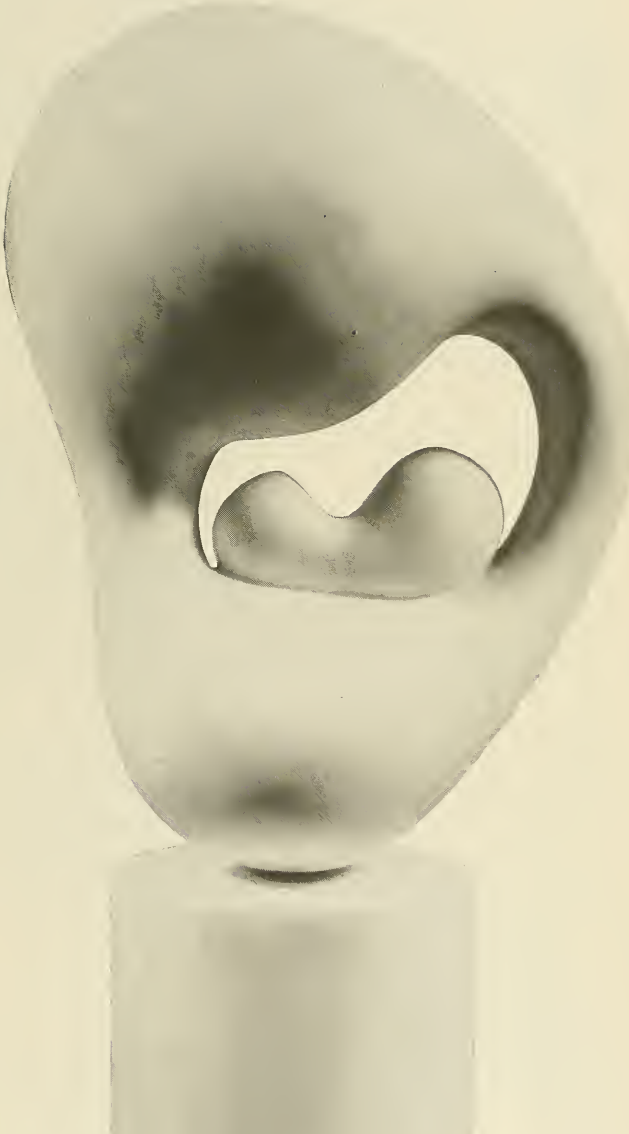
The "turfs" of the gangs of adolescent hoodlums are the nearest thing to territories in a modern city. I can think of no way of determining whether these represent the arousal of some latent instinct in these youth, or whether they are a secondary de-

velopment, only analogous to the territories of wild animals. Jane Jacobs, in her thought-provoking book *The Death and Life of Great American Cities*, discusses the extension of the turf idea to exclusive residential areas where no strangers are wanted. This surely is cultural rather than instinctive—as, I think, are all forms of discrimination.

To explain discrimination in terms of peck order seems to me as far-fetched as to explain war in terms of territoriality. Some vague leftover of inborn aggression may be found in the one, and of dominance in the other, but they are well buried under accumulated ideas. The peck-order pattern that emerges in prisons, schools, and adolescent gangs may well have an instinctive basis; but this dominance among a group of individuals seems to me different from mass discrimination against Negroes, Jews, Protestants, Indians, et al.

Dominance hierarchy in our society is largely formal: rank in the armed forces, chain of command in business, position within the university, and the like. Whether the drive to become a general in the army is comparable with the drive of a gorilla to become the Old Man of the tribe, I don't know. But in both cases the structuring serves to promote the stability of the group.

The human animal obviously can be crowded into quite dense aggregations without striking physical or mental deterioration—if there are ample resources for support. I tend to think this is partly due to the weakness of our territorial drive and the formality of our system of dominance hierarchy. This is comforting when one looks at those multiplying billions in the years ahead, except that there is always the catch about resources. The vice and misery of the Malthusian propositions will not necessarily persist if we can find food, housing, and some amenities for all of mankind. But it takes considerable optimism to think this possible. Under present conditions crowded people are apt to be miserable people who sometimes act in as bizarre a fashion as Calhoun's rats. The plea of the Kerner report that we must do something about the ghettos in our cities is surely valid if we wish to have a healthy nation.



Nid-Enchanteur, *Jean Arp*

Biology is the most visual of the s
ences. Many of its principal conce
find direct expression in drawings
diagrams: the cell, the phylogene
tree, the double helix. Unlike physi
which seeks to analyze entities in
their component parts, biology see
to treat over-all properties, to rep
sent the whole living system rath
than simply illustrate its isolat
parts. The biologist must regard l
subject with unusually close atte
tion, seeking to fathom its essent
character while rejecting superfic
impressions that might mislead l
inquiry. Nowhere is this more tr
than at the limits of vision, in the i
terpretation of microscopic form
through which so many of the gre
discoveries of the past century ha
been made. The early stages of er
bryonic development, the charact
of cell division, and the enviro
mental responses of bacteria ha
come to be understood because t
subtlest aspects of visual eviden
about exceedingly minute organisı
have been successfully interpreted.

The German poet Goethe, who w
keenly interested in biology, mai
tained that a great scientist should
able to perceive truth directly l
studying the visual aspect of orga
isms. He believed that scientif
facts had a sensuous basis and th
the task of the biologist was to pr
sent a "portrait of organic nature
Goethe's attempts to discover a
ideal plant form and a single type fo
all vertebrates had little scientif
value, but the primacy he claimed fo
vision has been of great consequen
for all subsequent biology. As cri
cal and rationalistic an investigat
as Thomas Henry Huxley recogniz

THE BIOLOGICAL MUSE

by Philip C. Ritterbush

ıe prominence of visualizations in ology, calling them "that fashionıg by Nature of a picture of herself ı the mind of man, which we call ıe progress of Science." Huxley ıade that comment, as it happened, ›llowing his own translation of "On ature," a prose poem by Goethe, hich he had prepared for the first sue of the scientific weekly *Nature.*

The golden age of cellular biology ı Germany, toward the end of the ineteenth century, was dominated y investigators whose keen esthetic ›nsibilities were typified by their se of superb illustration. Their ıotto might have been the frequently repeated statement by the botanist Julius von Sachs, "What has not been drawn has not been seen." Theodor Boveri, one of the most brilliant microbiologists in history, was an accomplished painter in oils. Santiago Ramón y Cajal, the Spanish histologist who was a co-winner of the Nobel Prize in 1906 for his discoveries of nerve structure, had hoped as a child to become an artist. He wrote, "The garden of neurology holds out to the investigator captivating spectacles and incomparable artistic emotions. In it, my esthetic instincts found satisfaction at last." Carl Chun, the marine zoologist, painted frescoes on the walls of his house, and H. Doflein, the protozoologist, did watercolors. But perhaps the most noteworthy example of the biologist's esthetic involvement was Ernst Haeckel, whose drawings of minute marine organisms showed remarkable sensitivity to the formal properties of beauty. Haeckel exaggerated the regularity and symmetry of the organisms he drew, and sometimes introduced elements that had no counterparts in nature into his drawings. The Radiolaria, which were his particular specialty, are among the most exquisite objects in nature—only too apt to excite his imagination and mis-

Departure Through the Umbrellas, *Leon Kelly*

In travelling from
one end to the other
of the scale of life,
we are taught one lesson,
that living nature
is not a mechanism
but a poem;
not a mere rough
engine-house for the
due keeping of pleasure
and pain machines,
but a palace
whose foundations,
indeed, are laid on the
strictest and safest
mechanical principles,
but whose superstructure
is a manifestation
of the highest
and noblest art.

Thomas Henry Huxley

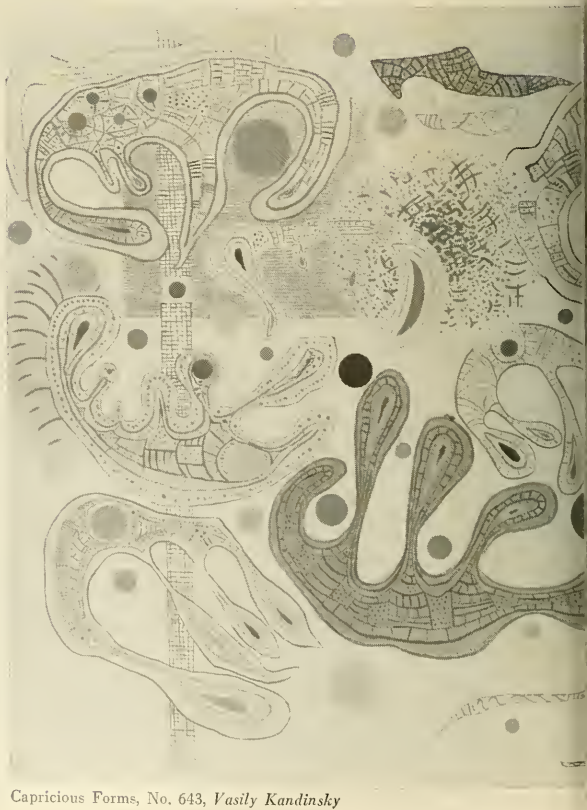
Proteus Changing I, *Richard Boyce*

lead his eye. Between 1899 and 1904 Haeckel issued a series of one hundred lithographs of natural forms, many in brilliant color, entitled "Art Forms of Nature," which testify to his pronounced artistic leanings.

The character of natural beauty was a question of central concern to the Romantic critics and poets. Keats emphasized the affinities between plant forms and that most beautiful of human artifacts, the Grecian urn. Wordsworth exalted natural form over the elements of geometry, praising the figure of a shell "so beautiful in shape," which on being held to the ear gave out "A prophetic blast of harmony" unknown tongue that was nev less mysteriously comprehe and articulate (*The Prelude,* Book V). The correlation be beauty and organic form was most strongly by Coleridge, in poem *The Rime of the Ancient ner,* the central figure is repel the "thousand thousand things" moving in the sea, u experiences a change of hea sees the beauty in the "rich att the water snakes and the elega their tracks of "golden fire" they "coiled and swam."

Whenever a little persistent study
of nature is made (as . . . in the
interest of mechanical inventions)
rapid progress at once follows in the
arts: and art is the true discoverer,
the unimpeachable witness to the
reality of nature. The master of
any art sees nature from the inside,
and works with her, or she in him.
Certainly he does not know how
he operates, nor, at bottom,
why *he should: but no more does she.*
His mastery is a part of her innocence.

George Santayana



Capricious Forms, No. 643, *Vasily Kandinsky*

ıppy living things! no tongue
ıeir beauty might declare:
ıg of love gushed from my heart,
nd I blessed them unaware . . .

dge thought that organic form
sed the basic principles of
and that the greatest works of
ure, such as Shakespeare's
were organic in their form.
ntioned certain characteristics
ganic form: that the over-all
was primary and pre-eminent,
its parts were only secondary
ortance; that it presented the
rance of growth, rather than
bly from pre-existing units;

Flower and Animal Head, *Max Ernst*

and that it was more complex than the non-living form.

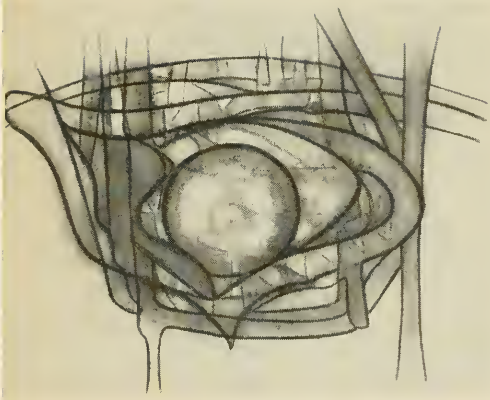
If, as Coleridge believed, organic form expresses the essence of natural beauty, then the biologist would be fortunate, indeed, to be the scientist engaged with nature in her most beautiful aspect. His appetite for beauty would be rewarded by the disclosure of pre-eminently beautiful form, and the esthetic sense would be auspicious for knowledge. Propositions such as these played a central part in Immanuel Kant's esthetic philosophy, and the nineteenth-century biologists who discovered the basic principles of organic form were finding a basis in practice for an esthetic philosophy perfected several generations earlier. For example, the cell theory, given its first full statement by Matthias Schleiden and Theodor Schwann in 1838, represented organisms as composed of uniform parts—elementary units constituting all living bodies—so that the whole was greater than the sum of its parts, whose functions nonetheless contributed to the achieved form of the entire organism.

In the early decades of the twentieth century, a number of painters began to employ abstract, curvilinear forms in compositions, as though to express the essential beauty of nature without relying on concrete illustra-

tions of scenery or familiar subjects. These were neither statements of scientific fact nor copies of biological illustrations. They manifest the formal properties of organic form without explicit biological subject matter. Paul Klee was an artist of great sophistication, whose determination to develop new expressive techniques led him to take a course in anatomy and to collect shells, flowers, and other natural objects, which held a lifelong fascination for him. He was greatly intrigued by the beauty of the organisms he saw in the Naples aquarium during his Italian tour of 1902. Many of his earlier compositions present what he called a "spatial organism"—irregular but rhythmic lines defining a space seemingly charged with potentialities for

types entitled *Histoire nature* (1926) shows a progression from ert crystalline substance, to sinu images of nascent life, to orga sheaths and membranes. Joan M included in his elegant compositi in the 1920's forms that resem ciliated protozoa and bacteria.

A leading student of Surrealist a Professor William Rubin, has w ten that such biomorphic form is "major common denominator" such painters as André Masson, Ma Yves Tanguy, and Arshile Gor Pavel Tchelitchew described his as "reflecting in its nature and pr erties the microcosm of the infinit small world of biology." As one co temporary painter, Lawrence Ki ferman has written, "out of the



Either/Or #II, *Nuala (Elsa de Brun)*

The Familiars, *Paul K*

growth and life. "Hanging Fruits," "Cacti," "Male and Female Plant," "Botanical Theater," and "The Fruit" are examples of works profoundly affected by his interest in the growth and sexuality of plants. Max Ernst cut illustrations from anatomy books and mounted them in witty compositions. Many of his early works show transformations of form reminiscent of embryological diagrams. The folio of thirty-four collo-

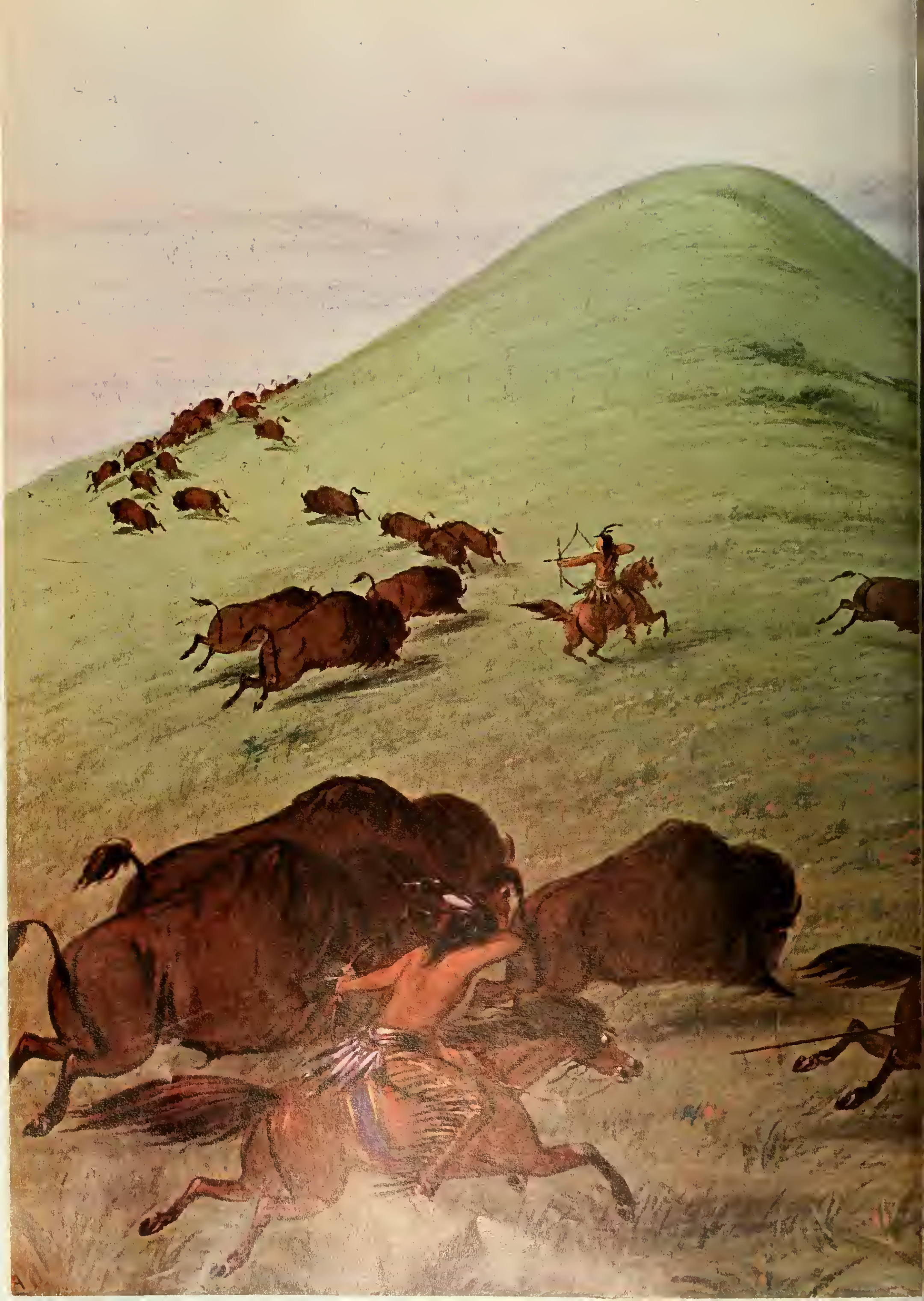
nute world of the microscope I c find symbols of universal growth a life." While these artists are not cop ing from science, they are adapti its forms to their own expressive pu poses. It is not that art is becomi indebted to science, but rather th both fields have been enriched by common esthetic heritage. They a interdependent features of our cu ture, incapable of continued progre in isolation one from the other.

The Seeded Earth. *André Masson*

Then does the artist have to deal with
microscopy? History? Paleontology?
Only by way of comparison,
only by way of gaining greater scope,
not so that he has to be ready
to prove his fidelity to nature!
The main thing is freedom,
a freedom which does not necessarily
retrace the course of evolution,
or project what forms nature will
some day display, or which we may some
day discover on other planets;
rather, a freedom which insists
on its right to be just as inventive
as nature in her grandeur is inventive.
The artist must proceed
from the type to the prototype.

Paul Klee

Tidal Maze, *Lawrence Kupferman*



Rise and Fall of the Indian of the Wild West

by Peter Farb

To many people, the typical North American Indian was the Plains Indian, a painted brave in full regalia, trailing a war bonnet, astride a horse that he rode bareback, sweeping down on a wagon train, in glorious technicolor. In actual fact, the picturesque culture of the Plains Indian was artificial, not aboriginal, and it lasted only about seventy-five years.

This response to alien influences emerged almost inconspicuously in the middle of the eighteenth century as its catalytic agent, the horse, spread northward from Spanish settlements in New Mexico. Within only a few generations, the horse was found throughout the central heartland of the continent, and In-

Lacking horses, Sioux, wearing animal skins, stole up on bison: above, George Catlin painted himself into the scene (taking notes). Below, in Mandan version of self-torture, weight of bison skulls pulls at skewered flesh of hanging youths.

dians from all directions spilled onto the plains. They originally spoke many different languages and had various customs, but they all found in the horse a new tool to kill greater numbers of bison than they had ever believed possible. They became inconceivably rich in material goods, far beyond their wildest dreams, and like a dream it all faded. Their fate had been sealed with the arrival of the first miners and the first prairie schooner. The battles of extermination between Plains Indians and United States cavalry represent America's own great epic —its *Iliad*, its *Aeneid*, its Norse saga —but this epic was no more true than any other.

There was remarkably little formal combat. Deaths and hardship there were, in plenty, as the Indians met their catastrophic end. but most deaths were due to starvation, exposure, disease, brutality, and alcoholism—not to bullets. In all the actual battles between White soldiers and Indian braves, only several thousand deaths on both sides were due to bullets and arrows. The wars of the plains were not epics but mopping-up operations. In the process, the millions of bison very nearly vanished without leaving any survivors, the plains were turned into a dust bowl, and the once-proud Indian horsemen were broken in body and spirit.

No Plains Indians rode in all their glory when they were first seen by the Spaniards under Coronado. Reaching what is now Kansas, in 1541, the Spaniards saw the beast they had been hearing so much about: the remarkable "cow," actually a bison, and also met some impoverished Indians who lived in conical tipis "built like pavilions," according to the chronicler of the expedition. He was particularly impressed by the way the bison seemed to provide most of the materials needed by the Indians: "With the skins they build their houses; with the skins they clothe and show themselves; from the skins they make ropes and also obtain wool. With the sinews they make threads, with which they sew their clothes and also their tents. From the bones they shape awls. The dung they use for firewood, since there is no other fuel in that land. The bladders they use as jugs and drinking containers."

Hunting bison on foot was not productive, and it certainly could not support large numbers of Indians. Such hunting was practiced largely by the wretched nomads who moved around in small groups, living off the occasional weakened bison they could kill or those they could stampede over bluffs. Most of the aboriginal cultures in the plains and prairies were based on the cultivation of maize, beans, and squash.

Once the horse arrived, that way of life changed. The Indians did not know the horse until the Spaniards brought it to the New World, for sometime during the great glacial melt it had become extinct in North America. The Indians obtained the first horses after the Spaniards settled New Mexico in 1598. The Spaniards prohibited the sale of horses to Indians, but the revolt of the pueblos between 1680 and 1692 resulted in large numbers of captured horses reaching the Indian markets. The Spaniards restocked their herds, which proliferated, but they were unable to prevent horse stealing by Indians. In addition, some Spanish horses had gone wild and roamed the plains in herds. The Spaniards called them *mesteños* ("wild"), from which the English word "mustangs" is derived.

By the first half of the eighteenth century, enterprising Indian merchants had already sold horses to Indians as far north as the Northern Shoshoni of Wyoming. The Shoshoni learned to ride as if they had been born to the saddle. No longer impoverished and secretive inhabitants of the Rocky Mountains, they swooped out onto the plains, where they found a bonanza in bison and a way to even the score with their traditional persecutors, the Blackfoot. From all over, other Indian groups converged on the plains and quickly adapted themselves to an economy based on the bison. The lands of the agriculturists were usurped.

The horse was a new cultural element in the heartland of North America. The whole of the plains, from Alberta to Texas, became peopled by groups of great diversity, which had come from all directions: Athabaskans from the north (Kiowa-Apache); Algonkians (Cree, Cheyenne, Blackfoot) and Siouans (Mandan, Crow, Dakota) from the east; Uto-Aztecans (Comanche, Ute) from the west; Caddoans (Pawnee. Arikara) from the south. The plains became a melting pot for more than thirty different peoples. belonging to at least five distinct language stocks.

By about 1800 the gross differences in culture among all these peoples had disappeared; the Sun Dance ceremony, for example, was eventually observed by virtually every tribe. Of course differences apparent to the trained eye of the anthropologist still existed; yet it is remarkable that a people from the eastern forests and another from the Great Basin of the west, two thousand miles away. should. within only a few generations, have become so nearly identical. Even more remarkable. this homogeneity was achieved with great speed, was not imposed on unwilling people by a more powerful group, and was done in the absence of a common tongue—save for "sign language," the lingua franca of the Plains tribes.

And all this was due to the horse. No longer were just stray or stampeded bison taken; the herds were pursued on swift horses and the choicest animals killed. No longer was the whole animal utilized for raw material: the Indians could now afford the luxury of waste. Even though most of the Plains Indians never saw a White close-up until their swift decline, his influence was felt profoundly as his goods and trade articles flowed westward by barter from one tribe to another. Tipis almost twenty-five feet in diameter were filled to overflowing with new-found riches. The women no longer toiled in the fields—for gardening was not as profitable as hunting—and they stopped making pottery because brass kettles were obtained from Whites. Permanent

villages disappeared; with them went the elaborate customs and crafts, the rules for marriage and residence.

After the Indians discovered the effectiveness of rifles, an armaments race began on the plains. Just as they had earlier realized the value of horses, so that those lacking them were driven to obtain them by any means, their acquisition of rifles upset the entire balance of power. As soon as one tribe acquired firepower, the competition for others to obtain equal armaments became fierce. For a period of nearly fifty years, the plains became an arena of turmoil in which the status quo changed from year to year, as successive groups became supreme in supplies of horses or guns or in the powerful allies they could muster.

In their heyday the Plains Indians were just as make-believe as the set for a western movie. They sprang from greatly differing traditions—farming, hunting, collecting of wild plants—and each contributed something of its own that created, almost overnight, a flamboyant culture. In this world of hyperbole, many traditions that also existed in non-Plains Indian societies became wildly exaggerated. Other Indians possessed clubs and associations, but none were so extravagant in ritual and insignia as the Plains warrior societies. Indians elsewhere also believed in the reality of visions, but none were so caught up in the emotional excesses of religion as the Plains tribes. Other Indians tortured captives, but none evoked pain so exquisitely in their own bodies.

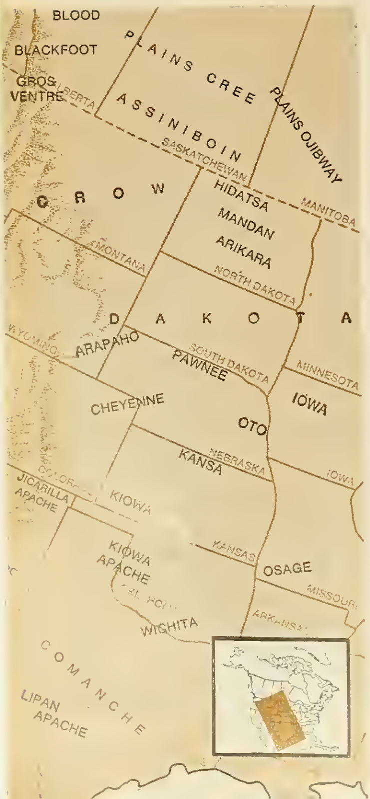
A special kind of social organization, known as the composite tribe, developed on the plains. Wherever the composite tribe is found throughout the world, it always signifies a breakdown in culture with a subsequent readaptation. Whatever the cause, composite tribes usually arise after an alien culture appears.

A distinguishing characteristic of such tribes is that descent reckoning is unspecific: it can be through either the father's or the mother's line, or both. Marital residence rules also are unspecific, and the newly married couple lives with whichever relatives expediency suggests.

The composite tribe of the Plains Indian was much more a collection of bands than were the lineal tribes of the Zuni or the Iroquois, both of whom had clans composed of relatives as well as strict rules of marriage and residence. During most of the year the bison lived scattered in small herds, but during the late summer rutting season they came together in huge herds that blackened the plains. The Indians responded with a parallel social cycle. Most of the year a number of families lived together as a band, uniting with other bands for tribal ceremonies and a communal hunt only at the time of the summer encampment. Furthermore, band membership tended to change. One cause was the constant feuding within bands.

Tribal identity was achieved mainly through non-kinship sodalities, not through clans. In modern society sodalities are equivalent to

PLAINS INDIANS BY TRIBE AND LOCATION



fraternities and sororities, political parties, service clubs like the Rotary or the Lions, and religious organizations. They bind people together around a single interest. When the Plains tribes united in the summer, they were crosscut by a bewildering variety of sodalities with ceremonial, social, and military functions. There were dance societies and feasting societies, and even societies based on a common supernatural experience. Some were only for women, like the craft guilds of the Cheyenne. Others were open to both men and women, like the tobacco societies of the Crow, which revolved around the raising of special kinds of tobacco for use on ceremonial occasions.

Left: two views of Sun Dance, painted by a Dakota chief, Short Bull. Below: a Mandan bison dance in 1830's, by artist Carl Bodmer.

The Cheyenne, as just one example, had six military societies that somewhat resembled the dueling societies of German students. A youth was permitted to join any one of them if he could demonstrate his courage, but he usually chose the one his father belonged to. These societies served not only as the tribe's military force but also as its police. Each of the six had a particular area of responsibility, such as protecting the movement of the encampment from one place to another or enforcing the rules against individual hunting that might scare away the bison. Only the bravest of the brave warriors could belong to the elite military society known as the Contraries. These privileged clowns did the opposite of everything: they said *no* when they meant *yes*; went away when called and came near when told to go away; called left *right*; and sat shivering on the hottest day.

A special development in the warrior societies—arrangement in order of the age of their members—was found among the Mandan, Hidatsa, Arapaho, and Blackfoot. As the members grew older they moved up a step; a society existed for every male from the youngest to the oldest, with the exception of the effeminate male known as a berdache. No scorn was attached to his position; he was regarded with pity and with a degree of sacred awe for being the victim of a condition that was not of his own doing. Even the berdache found his place. He permanently adopted women's clothing and women's roles; he became skilled in the female tasks of beadwork or tanning and was eligible to join the women's societies.

Almost all the sodalities were concerned with war in one way or another. The Plains Indians fought, not to win territory or to enslave other tribes, but for a variety of different reasons. One was the capture of horses. Another was that external strife served to unify the tribe internally. A third reason was that war was regarded as a game in which

the players might win status. In this game, exploits were graded according to the dangers involved. The exploit itself was known as the coup, from the French trapper's word for "blow," because, originally, it signified that the brave had struck the enemy's body with a special stick often striped like a barber pole. Later, "counting coups" referred to the recital by the brave of all his war deeds; as he immodestly proclaimed each one, he gave a blow against a pole with his ax.

Each Plains tribe had its own ranking for coups. Among the Blackfoot, stealing an enemy's weapons was looked upon as the highest exploit. Among some other tribes, the bravest deed was to touch an enemy without hurting him. The least important exploit usually was killing an enemy, but even that deed was ranked according to the way it was done and the weapons used. Like a sort of heraldry, these deeds were recorded in picture writing on tipis and bison robes, and gave the warrior the right to hold public office. Among many tribes, each coup earned an eagle's feather, and the achieving of many coups accounts for the elaborate headdresses of some of the Plains war leaders.

Scalps taken from dead or wounded enemies sometimes served as trophies, but they were insignificant when compared with counting coups. Many Plains tribes did not take scalps at all until the period of their swift decline, which began in the middle of the last century. Many historians still question whether scalping was an aboriginal Indian practice or, rather, one learned quite early from the White settlers.

There is no doubt that scalping quickly spread over all of North America, except in the Eskimo areas; nor is there any doubt that its spread was due to the barbarity of White men. White settlers early offered to pay bounties on dead Indians, and scalps were actual proof of the deed. Governor Kieft of New Netherland is usually credited with originating the idea of paying for Indian scalps, as they were more convenient to handle than whole heads and offered the same proof that an Indian had been killed.

Among the Plains tribes, apparently only the Dakota and the Cree placed any value on scalps; both tribes were late immigrants from the east, where they probably learned the practice from Whites. Nor was there as much torturing of captives by Plains tribes as was once believed. The tradition of the White settler saving his last bullet for himself to avoid a horrible death was a needless precaution. Unlike the Indians of the eastern woodlands, the Plains Indians killed swiftly. They looked upon the White custom of hanging, for example, as cruel and barbaric.

The Great American Epic has traditionally regarded the Plains Indians as the most "warlike" on the continent. Indeed, history does confirm that the heartland of the continent was an arena for continual strife. Yet, stating that a Blackfoot, for example, was "warlike" explains nothing. The fact is that the individual Blackfoot was warlike simply because his whole cultural system obliged him to be that way.

This explanation avoids confusing the issue with related problems, such as individual motivations or the kinds of warfare practiced. The Plains Indians confirm this cultural explanation. For one thing, the composite tribes could not have survived without external enemies, real or imagined, against whom their warrior associations could unite. For another, the Plains culture was artificial, brought into being by reverberations sent across the continent by the arrival of Whites, which upset delicate adjustments Indians had made to each other over very long periods of time. As just one example, the French encouraged warfare between the Ojibway and surrounding groups; the Ojibway spread westward and displaced Siouan tribes, which migrated westward and southward to the plains; there the Sioux displaced Hidatsa and Mandan, who in turn stirred up the Cheyenne and others. The whole unreal situation was very much like a series of balls caroming off one another and resulting in new rebounds.

Most important, once all these groups were on the plains and had altered their cultures by acquiring horses and guns, their whole make-believe world had to be kept in motion or it would collapse. Horses had to be stolen so they could be bartered for more guns to aid in the stealing of more horses. Many White traders encouraged the strife to capitalize on it by selling guns, liquor, and kitchenware. The herds of bison,

With horses, the Sioux could race as well as hunt and fight.

Painted on bison skin are exploits of a Pawnee warrior. Below: a Dakota chief in full regalia of the late 1800's.

once thought limitless, dwindled, and as they did there was additional cause for strife over hunting territories. In any event, there were good cultural—that is, social, political, economic, and technological—reasons why the Plains Indians were warlike. They were that way, not because of their biology or their psychology, but because their new White-induced culture demanded it.

Among the Mandan, Hidatsa, Arapaho, and Blackfoot, a member of a war society purchased his way up the ladder of age-grades until he arrived at the topmost grade and was thereupon entitled to wear the famous feathered bonnet. At each step, he selected a seller from the next older brotherhood, and then purchased his rights. A buyer was free to select any seller he wanted, but he usually chose someone from his father's family. Often, as part of the payment, the purchaser had to relinquish his wife to the seller for a time; if the purchaser was unmarried, he had to borrow a wife from a relative. The whole business of joining an age-grade brotherhood was accompanied by an elaborate and somewhat sophomoric etiquette, not unlike the mock seriousness of today's Masonic initiation.

Membership in other kinds of societies was also often purchased. In fact, many things were for sale among the Plains tribes: sacred objects, religious songs, and even the description of a particularly good vision. The right to paint a particular design on the face during a religious ceremony might cost as much as a horse. Permission just to look inside someone's sacred bundle of fetishes and feathers was often worth the equivalent of a hundred dollars. A Crow is known to have paid two horses to his sponsor to get him invited to join a tobacco society, and the candidate's family contributed an additional twenty-three horses. A prudent Blackfoot was well advised to put his money

into a sacred bundle, an investment as safe as today's government bonds —and readily negotiable at a price usually higher than the purchase price. By permitting the bundle to be used in rituals, its owner received fees that were like dividends.

Until they became horsemen, almost none of these tribes had ever known wealth. The Comanche, for example, had been an impoverished Shoshonean people from the Great Basin before the nineteenth century. Most of the other tribes only a few decades before had been marginal hunters, all of whose possessions could be dragged along by a single dog. But the Plains tribes learned the laws of the marketplace rapidly, both from each other and from the White trader.

What might have happened to the concept of wealth had the Plains culture endured for another century, or even for a few more decades? Some indication is given by tribes such as the Kiowa, who learned how to use wealth to create more wealth. A Kiowa warrior was forced by custom to give away some of his wealth, but he also learned to hoard it—for himself and also to keep in his family through inheritance. Classes based on wealth arose in what had once been an egalitarian society. The wealthiest classes could afford to give their sons the best horses and guns and send them down the road to military glory at an early age. The scion of a wealthy Kiowa, with his well-publicized exploits, could increase his wealth even more because he easily obtained followers for a raiding party.

The sudden wealth achieved by the mass slaughter of bison changed customs in other ways also. It took only a moment for a man on horseback to kill a bison with a bullet, but it still remained a long and arduous task for his wife to dress the hide for sale to the White trader. As a result, a shortage of women arose and a premium was placed on them to the extent that eventually bride price was paid. Men always needed the hands of extra women to dress the skins, and the parents of a healthy girl could negotiate her marriage from a position of strength. At the same time, polygyny, which probably had existed in some tribes to a limited extent, became widespread, for a good hunter needed as many wives as he could afford. There are even instances known of berdaches being taken as second wives, not for any sexual variety they might offer, but because they performed women's tasks.

Most North American Indians greatly respected visions, but few immersed themselves so deeply in them as did the Plains tribes. Sometimes a spirit might come of its own accord in a vision, but usually the Plains Indian had to go in active pursuit of his vision—by isolating himself, fasting and thirsting, and practicing self-torture, at the same time imploring the spirits to take pity on his suffering. The youth gashed his arms and legs, and among the Crow it was the custom to cut off a joint from a finger of the left hand. Cheyenne vision-seekers thrust skewers of wood under pinches of skin in the breast; these skewers were attached to ropes, which in turn were tied to a pole. All day the youth leaned his full weight away from the pole, pulling and tugging at his own flesh while he implored the spirits to give him a vision. (The George Catlin painting on page 34 shows a Mandan variation of the ordeal.)

The spirit might at last take pity on him—actually it was dehydration, pain, and delirium taking effect—and give him supernatural guidance. A successful vision supported the youth for the rest of his life; he had a guardian spirit on whom he could always call for help and guidance. During his vision, the youth usually learned what items—such as feathers, a stone pipe, a piece of skin, maize kernels—he should collect in a small pouch as a sacred medicine bundle. Those youths who could not obtain a vision of their own could sometimes purchase one, as well as a replica of the successful visionary's sacred medicine bundle.

The visions were clearly recognized as differing from person to person and from tribe to tribe. Some of the individual differences were biological and psychological; an Indian with an "auditory" personality might hear loud calls of birds or gibberish songs, whereas a "visual" type would be apt to see a horse with strange markings. Probably some individual fears and anxieties went into the vision: a common one was the sudden transformation

A western epic ends: Custer's last stand, drawn at left by a triumphant Indian, Red Horse, led to the scene at right. This is tl contorted, frozen body of a Sioux, one of about 300 who were massacred by U. S. Army cavalrymen at Wounded Knee.

of rocks and trees into enemies, but the youth was made invulnerable to their arrows by his guardian spirit. Often the vision involved the visit of some animal. An eagle might fly by, the flapping of its wings sounding like crashes of thunder; bison, elk, bears, and hawks appeared quite often among the nobler beasts. Among the Pawnee (who alone of the Plains tribes had worked out an orderly system of religious beliefs, including a supreme being), the stars and other heavenly bodies entered quite freely into visions.

The kind of vision desired probably explains why some Indians took enthusiastically to the White man's alcohol and others did not. The use of firewater was particularly intense among the Plains Indians, as well as among the nearby forest Indians, the ancestors of many Plains Indians. Alcohol was promptly recognized as a short cut to derangement of the senses and hallucinations. Until the coming of Whites, the Plains tribes had been remarkably free from the use of hallucinogenic plants such as mushrooms or Jimsonweed. Nor had the Plains tribes learned that tobacco, which they smoked in a few ritual puffs, could be swallowed to produce considerable discomfort and emotional upset, the way many Central and South American Indians used it.

Only when the Plains culture was disintegrating rapidly, after about 1870, did a hallucinogenic cactus known as peyote take hold. Peyote is native to northern Mexico, but it spread like a grass fire from tribe to tribe as far north as the Canadian plains. Although used elsewhere in North America to a limited extent, it was most widely and promptly accepted by the Plains tribes. Peyote afforded a new way to seek visions; later, it also provided an escape from the humiliation of the complete defeat by Whites.

After the Civil War, a tide of White settlers streamed westward. Treaty after treaty was broken by Whites as the Indian lands were crisscrossed by easterners desirous of acreage and precious metals. At first, the Whites tried to restrict the Plains Indians to valueless territories, but that policy soon changed to a war of extermination. Said General William Tecumseh Sherman in 1867: "The more I see of these Indians, the more convinced I am that they all have to be killed or be maintained as a species of paupers." To help clear the Indians from the Plains, the Whites struck at their food base, the bison. Whites not only destroyed the animals themselves, but also got the Indians' collaboration by offering to buy vast quantities of such delicacies as bison tongue.

Tensions between Whites and Indians increased during the 1870's. On July 5, 1876, eastern newspapers reported celebrations of the young nation's centennial, and also the news of a humiliating defeat. The elite Seventh Cavalry, a tough outfit of 260 men—organized specifically for killing Plains Indians and led by Lieutenant Colonel Custer—had been annihilated by a combined force of Sioux and Cheyenne in the battle of Little Bighorn.

But for Sitting Bull and Crazy Horse, the victory over Custer was empty; it marked the beginning of the end for the Plains Indians. From waterhole to waterhole, they were pursued mercilessly by troops, their women and children were slaughtered before their eyes, their encampments and their riches were burned. The glory and the poetry had gone out of the Plains Indians. Mighty chiefs emerged from hiding as miserable fugitives, hungry and without bullets for their guns. The survivors, like so many cattle, were herded onto reservations, where rough handling, cheap whiskey, starvation, exposure, and disease severely depleted their numbers.

The very end of the Plains culture can be dated exactly. In 1890 the surviving Plains Indians enthusiastically listened to a native messiah who foretold the return of dead Indians and the magical disappearance of the Whites. Alarmed, the United States government sent out cavalry to suppress this Ghost Dance, as it was called. While being placed under arrest, Sitting Bull was accidentally killed; and some three hundred Sioux, mostly women and children waiting to surrender at Wounded Knee Creek, South Dakota, were massacred by trigger-happy troops. Wounded Knee marked the end of any hopes the Plains Indians still cherished. The Ghost Dance had proven as make-believe as the rest of their improbable culture.

SKY REPORTER

RETURN TO MARS More than four years have passed since a U.S. spacecraft radioed back the first close-up pictures of the surface of Mars, but next summer two more Mariners will flash by the red planet for an even closer look. The National Aeronautics and Space Administration hopes to obtain pictures of surface features as small as 300 yards across.

Although both probes will be launched between mid-February and mid-April, they won't arrive in the vicinity of Mars until sometime between the end of July and mid-August. One will be aimed to fly by the southern polar cap; the other will cross near the Martian equator. If all goes well, they will pass within 2,000 miles of the planet, rather than the 6,000 miles of the 1964 flight.

Scientists from three universities and NASA's Jet Propulsion Laboratory have designed equipment to gather data on the planet's atmosphere and surface.

TEEN-AGER'S COMET A 16-year-old boy, using a four-inch telescope, discovered the second new comet of the year. Mark Whitaker of Bishop, Texas, found the ninth-magnitude object the night of June 15; his discovery was confirmed by Norman G. Thomas at the Lowell Observatory in Arizona. The comet is now designated Whitaker-Thomas 1968b.

The comet faded to twelfth magnitude as it moved northward through the sky during the summer. Preliminary orbit computations indicated that it did not approach the sun closer than the earth's mean distance, 93 million miles.

Two other new comets of the year were reported from Japan. In April, Minoru Honda of the Kurashiki Observatory shared the discovery of 1968a with four coworkers (only the first three names were allowed; it is called Tago-Honda-Yamamoto). Then, on July 6, he found another one, an eighth-magnitude object moving north through Auriga near Capella.

PINPOINTING THE MOON Men have been plotting the course of the moon for some time—staring at it through telescopes, flying cameras around it, and even landing devices on it that dig holes in its surface. Yet it has not been possible to predict the moon's position within an accuracy of several hundred yards.

This is a small matter at a distance of 240,000 miles, but it does make a difference in the interpretation of data radioed back from the moon's surface. It also makes a difference in astronomers' use of the moon as a timepiece.

Amateurs must often contend with the difference when attempting to observe a grazing occultation of a star by the moon. For example, when fifteen observers are deployed at intervals of 400 feet across the line along which such a graze may be seen, it is not uncommon for as many as five stations to report a miss. The moon was not exactly where the best predictions said it would be.

Calculating the moon's motion through space is an exercise in higher mathematics. For even a rough estimate, the influence of the sun and the earth must be taken into account. For finer work, the small but significant influence of the major planets is also considered.

Now scientists at the Jet Propulsion Laboratory in Pasadena are refining the equations used to predict the moon's motion. Confirmation of their work comes from precise analysis of radio signals sent back from spacecraft on or near the moon.

The mathematicians discovered, as reported in *Science*, that certain errors in the moon's position occurred at regular intervals and that some of these intervals corresponded with periods of Venus and Jupiter. When the equations were adjusted accordingly, the radio trackers found that the errors between predictions and fact were greatly reduced.

ALL THE WAY WITH VENERA 4? Last October a Russian space probe parachuted to the surface of Venus, radioing back data on Venus' atmospheric pressure and temperature as it approached the planet. The Russians reported that their Venera 4 continued broadcasting until it landed on Venus. Some scientists are coming to believe, however, that the data may be misleading.

The air temperature recorded at Venus' surface was 536 degrees and the pressure was reported as 12 to 22 times that on the earth's surface. Calculations based on the craft's signals showed that the radius of the planet was about 3,770 miles. Natural radio emissions from Venus observed on earth, however, indicated a surface temperature of about 800 degrees. No mechanism other than this heat appeared to account satisfactorily for the emissions.

Two teams of radar astronomers attempted to resolve the dilemma, using microwave measurements made from Massachusetts, Puerto Rico, and California. Although the two groups worked independently, each found the radius of Venus to be about 3,750 miles, a difference of 20 miles from the Russian calculation. If the Russian probe stopped transmitting for some reason while still 20 miles above the surface, it is believed the discrepancy vanishes. Presumably the capsule would have found the pressure and temperature continuing to rise as it neared the ground. Extrapolation puts the temperature at exactly the 800 degrees measured from earth and the pressure at 100 earth atmospheres.

ANOTHER PULSAR Two Harvard astronomers have reported the discovery of a fifth pulsar (pulsating radio source) with the 300-foot radio telescope at Green Bank, West Va. G. R. Huguenin and J. H. Taylor located it on the border of Boötes and Draco near the galaxy M 102. The object is pulsing every 0.7397 seconds, give or take 0.0001 seconds.

JOHN P. WILEY, JR.

CELESTIAL EVENTS

Full moon occurs on October 6; last-quarter on the 14th; new moon on the 21st; and first-quarter on the 28th.

October 6: Today's full moon is the harvest moon. During the morning hours, it enters the shadow of the earth and a total lunar eclipse occurs. Only the beginning partial phase of the eclipse will be seen before moonset along the East Coast. Farther west, part or all of the total phase will be visible, and all but the ending partial phase will be visible on the West Coast.

The bright planet near the moon on the evening of the 6th is Saturn.

October 15: Saturn is at opposition and is now in the sky from sunset until sunrise. Mercury is at inferior conjunction, passing between earth and sun, and enters the morning sky.

October 19: The crescent moon in this morning's sky lies between Mars and Jupiter. Mars is well above and to the right of the moon, Jupiter quite close below the moon. Jupiter is occulted by the moon after sunrise.

October 20: The Orionid meteor shower reaches maximum, producing up to 25 meteors per hour. There will be no moonlight to interfere with after-midnight observations.

October 23-24: Venus is the bright planet above the moon on the evening of the 23rd, below and to the right of the moon on the 24th.

October 31: Mercury, at greatest elongation, may be seen low to the south of east at dawn for about a week before and after this date.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on October 1; 8:20 P.M. on October 15; and 7:20 P.M. on October 31; but it may be used for about an hour before and after those times.

A day in the life of a Polar Bear

by Fred Bruemmer

Follow the plantigrade spoor of a polar bear in the Arctic and you will be able to read the animal's story written in snow. At first the tracks show an aimless amble, but oon a purposeful patrol pattern emerges. The bear vandered from one iceberg to the next, approaching hem from leeward. It circled each berg, paying articular attention to the huge, wind-fluted snowlrifts. It was seeking *nunarjaks*, the oval lairs excaated under snowdrifts by ringed seal mothers as urseries for their pups. These are born with long, vhite, silky-soft fetal fur. Until they molt, at the age f three to four weeks, the pups cannot seek safety n the sea, since the natal coat would become waterogged and they would sink. If the bear can find them, hey are easy prey.

At the fourth berg, the spoor indicates success. Great chunks of compacted snow have been scooped rom a drift. Once the surface layer of snow had been emoved, the bear reared up on its hind legs, then lrove down with all its force to break through the ce-coated roof of the seal's lair. Two limp, furry lippers in the snow are all that remains of the pup.

A single seal pup, weighing perhaps 15 pounds, is ot much of a meal for a large polar bear, which can, given the chance, devour 150 pounds of blubber at a itting. With its peculiar, broad-legged, shuffling gait, our bear ambled on, its great furry paws leavng tracks 12 inches across. Abruptly, it had turned nd dug up something. A few feathers tell of a dead fulmar that had lain beneath the surface. The bear is both hunter and scavenger. Its nose will lead it to anything remotely edible.

The next berg is small. The bear had climbed it, its long curved claws digging into the ice like crampons. It used bergs as lookouts, to spot the dark, spindle-shaped seals near their breathing holes. Satisfied, it had glissaded down the other side of the iceberg, front paws outstretched to break the descent.

Now its tracks reveal a long, deliberate stalk. First the bear moved toward a pressure ridge and advanced behind it, obviously careful to keep downwind and out of sight of a seal snoozing beside its hole on a large level stretch of ice. Then, from the closest point of the sheltering ridge to the seal, the bear had crossed 200 yards of snow and ice, with not a single hummock to hide behind. Emerging between two ice blocks in the ridge, keeping flat on the ground, the bear had pulled itself forward with its front paws and pushed cautiously with its hind feet. A seal, however, is a fitful sleeper. It dozes, suddenly raises its head to look carefully all around for about 30 seconds, and then, satisfied that all is safe, slumps down to sleep for another minute or less. The instant the seal went to sleep, the bear, camouflaged by its yellow-white fur, inched forward. At a seal's slightest movement, a bear freezes into a motionless and indistinct yellowish hump. Only its big, shiny India-rubber-like nose stands out, coal-black in the surrounding whiteness. "It is unmistakable miles away,"

said the Arctic explorer Vilhjalmur Stefansson. The Eskimo insist a stalking bear covers its nose with a paw, and Peter Freuchen claims to have seen this.

When our bear was within about ten yards of the seal, it hunched up and with a tremendous burst of speed rushed upon the sleeping prey, grabbing it nearly simultaneously with teeth and claws, the long canines crunching through the seal's thin skull.

Having already eaten a pup, the bear was not too hungry. It stripped the carcass of blubber, a favorite food, and ate some intestines. The rest it left for its retinue, the arctic foxes who followed it in hope of leftovers. Replete, the bear shuffled back to the pressure ridge, stretched out on a sheltered ice block, and was soon sound asleep in the spring sun.

The polar bear's realm is vast, more than 5,000,000 square miles of circumpolar Arctic and subarctic. It is rare in the central polar basin itself, since this area is nearly devoid of seals, its main prey; but it has been seen as far north as 88°, within two degrees of the North Pole. And it ranges as far south as James Bay, nearly on the same latitude as London.

The Romans made the first historical mention of the polar bear in A.D. 57. Later, to titillate the spectacle-jaded public they pitted the great white bears against seals in aquatic battles staged in flooded arenas. In medieval times, bears became immensely valuable as gifts to be given to European monarchs, and many were imported for this purpose. Depending on whether their owners' ambitions were mercantile or spiritual, a polar bear could be traded for such treasures as a ship plus cargo, or a bishopric.

But it was not until the era of Arctic exploration and exploitation that Europeans, and later Americans, encountered and killed polar bears in large numbers. They were then numerous throughout their immense range. Whalers killed bowhead whales and walruses by the tens of thousands and stripped them of blubber. Where the flensed carcasses washed ashore or froze into the ice, bears congregated, led to this feast by their acute sense of smell. As many as a hundred polar bears were seen to feed at the remains of one whale. As the whales decreased, whalers supplemented their income by shooting polar bears. To have a polar bear rug in front of one's fireplace became a sort of status symbol in Victorian times, and the demand for polar bear skins continues nearly undiminished into our time. In recent decades an average of about 1,000 polar bears have been killed annually, and the total number left in the world is now estimated at only 10,000 to 12,000—about 6,000 of them in the Canadian Arctic.

Inveterate wanderers, polar bears still inhabit most of their former range. If this range has shrunl it may be due as much to the warming trend in Ar tic climate, as to overhunting. However, they are n nearly as numerous in this region as they once wer

The polar bear is a close relative of the Europea brown bear (*Ursus arctos*), both probably descend ed from an early Pleistocene ancestor, *Ursus etruscu*. In captivity brown bears and polar bears interbree and produce fertile offspring.

During the millennia since protopolar bears firs spread to the game-rich ecological niche of the Ar tic, they have become superbly adapted to this hars environment. Although polar bears seem to roam a random across the vastness of the Arctic, there ma be definite but still undiscovered patterns to thei movements. In late fall pregnant females seek ou very specific areas where they will bear their cub during winter. The main known denning regions ar Wrangel Island and Franz Josef Land north of Si beria (with about 150 dens each); Kong Karls Land an island east of Norwegian-owned Spitsbergen; th northeast coast of Greenland; northern Baffin Islan in the Canadian Arctic; and Southhampton Island i Hudson Bay.

As winter darkness descends upon the Arctic, eacl pregnant female (they become sexually mature a the age of four and mate in April) digs a large den i a snowdrift on the leeside of a hill or ridge. Winte winds soon cover her lair with a thick mantle o snow. Only a small vent remains open, created by th warmth the hidden animal exudes. The temperatur in the den is usually some 40 degrees warmer than th outside air temperature. In late November or Decem ber the young are born, usually one if it is the fe male's first birth, twins as a rule thereafter, and rarely, triplets. A newborn cub is only as big as a rat and weighs one to two pounds. The cubs lie in their mother's thick fur, off the chilly den floor, and suckle her fat-rich milk, while the female dozes away the days and weeks of winter. She is not in a state of torpor, merely lethargic, living off the thick layer of fat she has accumulated during late summer and fall.

The Canadian scientist Richard Harington studied denning behavior of polar bears on Southampton Island. After measuring the inside temperature of a den "we opened the hole wider to find out more about the occupants. A glistening black eye and twitching muzzle were instantly applied to the aperture by the mother bear. While she paced the den floor beneath us, uttering

peevish grunts, we were just able to discern her two young cubs huddled against the far wall of their snow house."

In March or April the mother digs a passage out of the dark den, and the cubs, now chubby and heavily furred, have a first look at the sparkling world of ice and snow. For the next two years they will stay close to their mother, who looks after them with great solicitude mingled with disciplinary sternness. From her they learn the art of the stealthy stalk, the location of seal-rich areas, and presumably, the best overland routes from one sea area to another.

Spring is the season of plenty for polar bears, and by this time many are grimly in need of food. The fat reserves of lactating females vanish during the long hibernation months. Only a few males den in winter. Most of them prowl the frozen bays and fiords, in dusk or darkness, searching for *agloos* (the Eskimo term for the breathing holes that ringed seals cut through the ice as vital air vents). Near them the bears lie in ambush to scoop out the seals when they come up to breathe. But each seal has many vents, and a bear may wait for days in vain.

In spring seal pups are easy prey. Molting seals snooze lazily along leads, which run, like dark, jagged rents through the tide- and current-moved mass of Arctic ice. Hunting now is easier for the bears, who trot along noiselessly on heavily furred paws. When the ice breaks up and moves with the currents, most bears remain on the floating pack, traveling from floe to floe in search of seals.

Once the pack ice begins to disintegrate, the bears move to the nearest coast. In southern Hudson Bay and its appendage, James Bay, polar bears may be forced ashore onto islands or the mainland as early as July. Although the bears are good swimmers, seals swim infinitely better and can always escape their pursuers in water. So, until new ice begins to form (in October in the northernmost range but not until the end of November in southern Hudson Bay), the bears are landbound and change from a predominantly carnivorous diet to one that is nearly wholly vegetarian (unless they are lucky enough to find a walrus or whale carcass). They eat grasses, sedges, sorrel, and seaweed, and in the fall gorge themselves on berries where available. In lemming years they systematically hunt these little rodents, and occasionally they raid colonies of eider ducks and snow geese, eating the eggs and catching a few brooding birds. In the fall of 1967, a hunter on the shores of

Hudson Bay saw a polar bear stalk one of his goose decoys with great patience and skill. At ten yards it pounced. but when it only got a mouthful of papier-mâché, it flattened every decoy in sight.

In winter, when prolonged storms make hunting impossible, polar bears dig temporary dens and retire to sleep until conditions improve. Similarly in summer, when food is scarce, some appear to go into temporary estivation. They dig pits, varying from shallow depressions to holes five feet deep, into sandy ridges, and there they sleep, expending a minimum of energy. During an aerial polar bear census of the James Bay-Hudson Bay region, conducted by the Canadian Wildlife Service during the summer of 1967, many bears were seen in these summering pits along the west coast of both bays and on many of their islands. As the plane flew low over 10-mile-long North Twin Island in James Bay, 24 curious polar bears popped out of their pits to have a look at this unusual disturbance. On neighboring South Twin Island, 18 polar bears had dug pits into a sand ridge. Later in the fall when. in order to tag them, Dr. Charles Jonkel and a team from the Canadian Wildlife Service captured and drugged polar bears at Cape Churchill, they caught several emaciated bears with unusually long fur underneath their paws, indicating that they had slept for a good part of the food-poor summer.

Despite their impressive size (bears measuring twelve feet in length and weighing a ton have been reported, although eight to ten feet and a weight of 700 to 1.000 pounds is more normal for an adult male) polar bears are not normally aggressive. They are only extremely curious. They will go far out of their way to examine anything unusual, be it a pole, a hut, or an abandoned sled. Where they are intensively hunted, they are shy of man (and his dogs) and flee at his approach.

Along the west coast of James Bay and as far north as Churchill on Hudson Bay, the bears are rarely hunted, and they show the same mixture of curiosity and indifference to man that so amazed and often frightened early explorers. In October and November, polar bears congregate every night at Churchill's garbage dump. People drive out in cars to watch them, yet the bears pay scant attention even when the vehicles come within a few yards.

When the Canadian Wildlife Service caught bears in snare traps near Cape Churchill, the polar bears, unlike grizzlies and even black bears, which fight fur ously in similar situations, made no attempt to figl or flee. Their behavior seemed one of passive resi nation. On several occasions, while the scientists wei working on a drugged bear, a free one would wand up to watch the proceedings.

Despite their apparent amiability, polar bears ca be dangerous. Although most attacks upon man ca be traced to provocation or surprise, cases of appa ently unprovoked attack have occurred. The mo recent of these happened in Churchill, where a larg male bear attacked two Indians at night and severe mauled them.

The lack of fear in the polar bear, even a trappe one. may be explained by the fact that on land has no natural enemy. In the sea, a walrus or kill whale may be dangerous, but on land the bear reig supreme and hence knows no fear instinctively. has to learn fear.

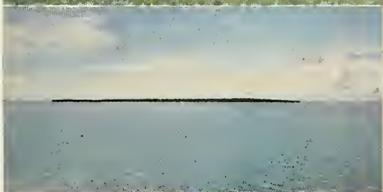
In recent years some measures have been taken t preserve the remaining polar bears. In the Sovi Union they have been completely protected sinc 1955. Only a few cubs may be captured under l cense for zoological gardens. In all other norther countries they receive at least partial protectio neither cubs nor females with cubs may be sho Kong Karls Land has been made a polar bear pr serve, Greenland and Alaska have closed season and in Canada only Indians and Eskimo may hu polar bears, on a quota basis.

Polar bears are a slow-reproducing specie Thanks to the prolonged period of maternal car most cubs grow to maturity, but this gain is offs since the female has, at best, only one or two cul every three years. To preserve polar bears in the present number. more extensive protective measur may have to be taken in the near future.

The polar bear, largest carnivore in the world (wit the possible exception of the Alaska brown bear has been known to Western man for nearly 2,00 years. Yet its seasonal movements or possible a nual migrations remain a mystery. Does it reall travel with the drift of the polar ice, from countr to country and continent to continent, as the Danis scientist Alwin Pedersen claims (some Russian sc entists, too, subscribe to this theory); or does eac polar bear belong to a purely regional group, wit fairly limited seasonal movements? At present, n one really knows the answers to these questions. Sca tered over the vastness of the circumpolar Arctic sea and their sparsely inhabited shores, the polar bea pursues its lonely patrols across the endless ice an snow, still far from the ken of man.

Lignumvita Relict Islan

by Edward O. Wilson
and Thomas Eisn



Above: historic cannon in clearing at Lignumvitae Key (sapodilla tree in background). Left: the island. Below: mangrove roots reach into sea.

To the north and south of Mia from Juno Beach to Homestead, other of America's megalopolise taking shape. Extending thro nearly one-third of eastern Flori this surge of men and machine gobbling up the sandy pinelands hardwood hammocks, filling the bottoms, ringing the scattered, sn lakes with dwellings, and dimin ing the once great Everglades to status of a threatened nature rese

Continuing farther south you the transformation process also ing on along U.S. 1 through Florida Keys. This is especially fortunate because what is being in the Florida Keys is much m precious than the vanished habi in the rest of south Florida—or th in almost all of the rest of the Uni States, for that matter. Here i unique set of island-land ecosyste composed of rich stands of West dian hardwood forests that are habited by a curious and interest mixture of animals—some of tr cal, some of temperate origin.

While doing research in the Fl ida Keys, we sought islands that harbor patches of undisturbed ha wood forests. Our purpose was gain an idea of the original comp tion and diversity of the faunas, order to assess more accurately history of animal life in the area. were repeatedly disappointed. though dense woodland still cov much of the upper and middle K including large portions of K Largo, Long Key, and other prir pal islands, it is generally in p condition and largely composed second growth. Another indicato change is that the famous tree sn of the genus *Liguus*, symbols of primitive Keys environment, h been mostly wiped out by the terioration of these forests and depredations of shell collectors.

anish wall, above, was built from ral rock. Right: ethologist Konrad renz made marine observations off s coral shore. Below: a close-up coral and emergent vegetation.



Bark patterns of some native trees on the island. From top left, (clockwise): blolly, gumbo-limbo, palm, false-mastic, pigeon plum, and lignum vitae.



However, one island we visited stands out as a remarkable exception to this destruction. This is Lignumvitae Key, appropriately named because of its several hundred lignum vitae trees, probably more than in all of the rest of the United States. This 280-acre island is located just 7,800 feet north of Lower Matecumbe Key and U.S. 1. It has been preserved—so far—by a series of private owners in what must be very close to its original state.

As we began to explore the island under the guidance of the caretakers, Russell and Charlotte Niedhauk, we found that, despite a long history of human occupation, its superb cover of forest remains. Archeologists have determined that Lignumvitae Key, together with the nearby Matecumbe Keys, Tea Table Key, and Indian Key, was long an important focal point of Indian activity.

The earliest known inhabitants were two tribes, the Vescaynos and Matecumbeses. These primitive Indians had no permanent dwellings. They moved about, living on fish, turtles, and the vegetation of the islands. Long before the coming of the Spaniards, however, these Indians had been replaced by the Tequestas, who migrated from the lower Atlantic Coast and upper Keys. (The Tequestas are sometimes confused with the Calusas, who occupied the zone along the lower Gulf Coast to the lower Everglades. Both tribes are usually referred to in popular literature as "Calusas.")

A Tequesta burial mound at the south end of Lignumvitae Key is in the transitional zone between the hardwood and coastal mangrove forests. Bones and charcoal in the mound, subjected to radiocarbon dating, have been found to be between 900 and 1,000 years old. Excavation of similar mounds elsewhere has shown that the Tequestas had a great fear of the dead and buried them in a fetal position facing east, in a constantly guarded place far from the campsite. When the cacique (chief) died one or two children were killed to accompany him. His grave was adorned with turtles and other animals, and with such goods as stones and tobacco.

When the Spaniards reached the Keys in the middle 1500's they enslaved many of the natives. By the late 1700's, the Tequestas were extinct; thereafter the only Indians encountered in the Keys were parties of Seminoles. As for Lignumvitae Key, the Spanish were reported to have occupied it at a very early date, possibly in the 1540's. Using Tequesta slave labor, they planted a grove of Seville oranges and constructed a wall, sentinel houses, and a few other dwellings on the south end of the island. The still existing wall and the ruins of a sentinel house show that construction was entirely of coral limestone gathered from the surface of the island. The wall was used to segregate cattle, horses, and the Indian slaves.

Spanish occupation was maintained intermittently until 1818, when the United States purchased Florida. Thereafter the history of this little island became especially colorful. According to local lore, the "gentleman pirate" Mitchell used it as his headquarters during the 1820's. Some believe that "Mitchell" was none other than buccaneer Jean Laffite, who disappeared after being driven from his Texas "Kingdom of Campeachy," in 1821. In 1825, Jacob Housman came to nearby Indian Key from Key West, where he had prospered as a wrecker. His dream was to establish a personal empire in the middle and upper Keys with the salvage money.

Housman was joined later by Dr. Henry Perrine, who had a different kind of dream. He wished to establish tropical agriculture in the United States. To implement this, he began planting century plants, *Agave sisalana*, on Lignumvitae Key. From *A. sisalana* comes sisal, the fiber used in the manufacture of rope and twine. Consequently, the United States Congress, hoping that Perrine could make the country independent of Great Britain for this product, gave him a grant of $75,000 and a completely free hand.

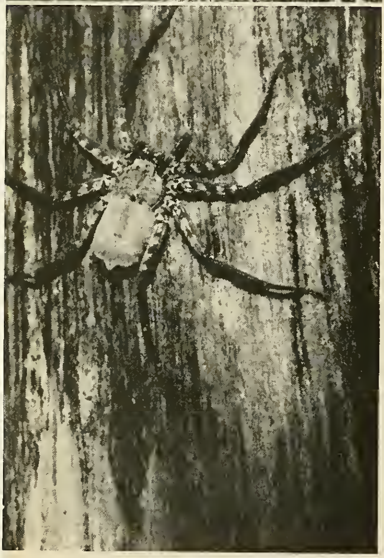
But Perrine's efforts came to a tragic end. In 1840, during the Seminole War, Housman sent a letter to Congress offering to kill the Indians of South Florida for $200 apiece. Congress went no further than to read the offer into the record, but the story was picked up by the newspapers and, surprisingly, a copy of one reached Chief Chekika of the Seminoles. When the account of the proposal was read to him, Chekika resolved to kill Housman without delay. Accompanied by a large party of braves in seventeen canoes, he traveled the more than seventy miles from his camp in the Big Cypress Swamp, on the mainland of Florida, to the central Keys. On August 7, 1840, the party camped near Indian Key, possibly on the rocky northwest shore of Lignumvitae Key, and that night launched an attack on the Housman settlement. Unfortunately, it was Perrine, together with several others, who was killed—Housman and most of the other residents of the Key escaped. So ended the nation's first venture in tropical agronomy.

Some of the history and legend of Lignumvitae Key has been captured in the treasure-hunting episode of Robert Lewis Taylor's well-known novel *Journey to Matecumbe*. The island also attracted Konrad Lorenz, the noted student of animal behavior. He was so impressed by the fish life he witnessed around its coral formations and dock pilings that his observations there and at Key Largo constituted the beginning of his book *On Aggression*, which has become one of the most influential popular scientific works of our time.

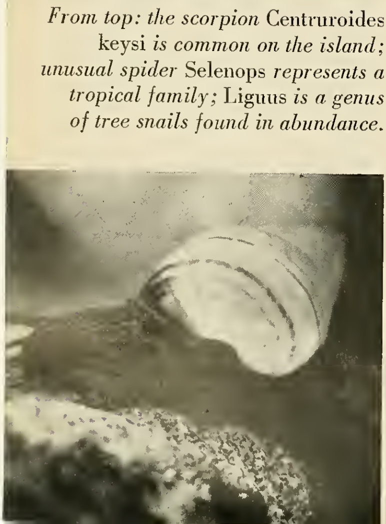
The long history of the little island can be traced by the ruins and plantings scattered over it. To anyone but a professional investigator, however, this testimony is all but lost in the luxuriant hardwood forest.

The island has no fewer than sixty-five species of trees and woody shrubs—one of the richest concentrations to be found in North America. They are almost entirely of tropical West Indian origin, and even their common names sound unfamiliar and often bizarre: strongbark, fishfuddle tree, boxleaf stopper, sea grape, blolly, torchwood, pond apple, pigeon plum, buttonwood, Florida strangler fig, black ironwood, poisonwood, lancewood, crabwood, cat's claw, thatch palm, hog plum, and many others. Not included are oaks, elms, pines, or any of the other familiar forms found in the forests of the United States.

More importantly, the forest on Lignumvitae is in better condition than any other on the Florida Keys. The mahogany (*Swietenia mahagani*) and false-mastic trees (*Sider-*



From top: the scorpion Centruroides keysi *is common on the island; unusual spider* Selenops *represents a tropical family;* Liguus *is a genus of tree snails found in abundance.*



oxylon foetidissimum) are numerous and very large. What may be the largest gumbo-limbo tree in the United States occurs near the center of the island. Because this species (*Bursera simaruba*) has a striking, reddish, paper-like bark it is a conspicuous element of the south Florida hardwood hammocks. A few individuals of the Florida fiddlewood tree (*Citharexylum fruticosum*) and the oxhorn bucida (*Bucida buceras*), two rare species threatened with extinction in the natural state elsewhere in Florida, also grow on Lignumvitae Key.

The single most interesting element in the island forest, however, is the holywood lignum vitae (*Guaiacum sanctum*) itself. The extremely resinous wood of the lignum vitae tree has a silky feel and is among the heaviest in the world, with a specific gravity in excess of 1.4 and weight of nearly 100 pounds per cubic foot. Consequently, it has been put to a variety of commercial uses requiring material that is self-lubricating and dense, yet workable: ball bearings, marine propeller-shaft bearings, and other parts needed especially for underwater service.

Tropical species from the West Indies and Central America annually supply thousands of tons of sizable logs up to two feet in diameter. The first-grade lumber is called the "filet mignon" of the log. Historically, this tree was valued for another reason. In 1508, only sixteen years after Columbus' first voyage across the Atlantic, the medical profession in Europe began to use the gum resin from this tree as a sort of cure-all, hence the name lignum vitae, literally "wood of life" or in other words, tree of life.

The species *G. sanctum* has always been relatively scarce, even in the Florida Keys, where its few remaining habitats outside Lignumvitae Key are being eliminated by real estate developments. The population on this island gives the appearance of being very old; and estimates made from tree-ring analysis do in fact place the age of the oldest individuals at over 1,000 years. Part of the reason for their enduring so long is to be found in the structure of the island. It is at a higher elevation than the rest of the Florida Keys, with no less than eighty acres standing sixteen feet or more above water level. Consequently, the region's hurricanes—including the tremendous "Donna" of 1960, which struck the island full on—have failed to push the sea into the interior.

The animal life of Lignumvitae Key is also rich and, in our opinion, is representative of the primeval fauna of the hardwood hammocks. We have observed many species of native insects and spiders that are scarce elsewhere in the United States; even unknown as yet on the remainder of the Florida Keys. Also, tree snails of three genera, including *Liguus*, are abundant on Lignumvitae Key. The bird fauna is not as distinctive but nevertheless contains a large sample of typically Floridian species: bald eagles, West Indian bananaquits (as occasional visitors), white-crowned pigeons, ground doves, and a variety of wading birds, including roseate spoonbills, white ibis, and great white herons.

To enter the forest on Lignumvitae Key is to step far into the past, and to come as close as we ever will to witnessing the Keys as they were before the coming of man. This fact, together with the circumstance that the island is an isolated ecological system, greatly enhances its value for future biological research. But in view of its proximity to U.S. 1, how long can we depend upon its remaining unravaged by the thrust of men and machinery?

At present, Lignumvitae Key remains in the hands of private owners who have taken commendably good care of it. The over-all prospects, however, are not encouraging. Monroe County, which includes Lignumvitae Key, is distinctly less diligent in matters of conservation and regional planning than is average for the United States; its political and business leaders are still given to that mindless form of purely economic boosterism that is the despair of conservationists.

We can only hope that arrangements will be made by the government or some other forward-looking agency to permanently preserve this unique island in its unspoiled condition. It would be an irreparable loss if the ecological system of Lignumvitae Key is allowed to go to ruin—and with it the "tree of life."

gnum vitae tree's flower, above,
:ad to oddly pointed
v fruit, seen clustered at right.
): this small lignum vitae tree
œe more than one hundred years old.

The Dolphin Observed

by
David K.
and
Melba C.
Caldwell

Atlantic bottlenosed dolphins have become the object of much interest—scientific, pseudoscientific, and popular. They have been investigated by anthropologists, engineers, linguists, physicians, veterinarians, acousticians, and even a few biologists and behaviorists in recent years. They have successfully broken into the science fiction field, and it must be admitted that some of the science fiction is better, and certainly more interesting, than some of the science.

Dolphins and related species, however, have an extremely important potential value to comparative zoologists and psychologists, so rather than an outright condemnation of the natural tendency to make dolphins into "little men in wet suits," let's take a quick look instead at the tendency's probable cause. The information value of the group is too great to permit its being off limits to research because of some of the poor data that has occasionally been presented in the past.

First, there is the engaging personality of dolphins. We haven't as yet met the person who can long remain emotionally unattached to individuals of this species. Dolphins seem to smile constantly. They are playful and are usually exerting pressure toward establishing an interplay with humans. Even their trainers, who are in some respects engaged in a lifelong battle with them, quickly establish such emotional bonds that unemotional evaluations are virtually impossible.

The large brain size, relative to body area, is a second characteristic that has triggered a deep interest in, and some unjustified speculation about, the species.

Thirdly, they are a novelty, both in terms of our limited experience with them and because anything that lives in the water is not expected to show any vestige of "intelligence," however one defines this nebulous term. A "fish," which dolphins aren't (they are mammals), just isn't supposed to be smart.

These deterrents to a clean evaluation of the species are relatively easy to overcome. Emotional involvement with the animals can be avoided by the researchers remaining completely out of contact with their experimental animals; even the feeding could be done by someone else, or by a machine. As far as the brain size is concerned, we have no factual knowledge of the function of the increased brain tissue. Until we have hard data on this, we have to keep in mind that the entire increase may only be devoted to distinguishing between a mullet and a scorpion fish. Finally, the novelty of the animals and the initial "oh my" reaction wears off after a few months of grueling research and reasonable behavioral evaluations become possible.

Behavioral studies of the bottlenosed dolphin have intrigued us for many years because of the potential insight they offer in comparative studies with terrestrial mammals, particularly in the field of social behavior. They offer us a highly social and obviously advanced species whose ancestors took to their aquatic

vironment more than 45 million ars ago. Some facets of their social havior should show gross differ- ices, indicating that widely differ- t solutions to behavioral problems e workable. Conversely, if this ecies has evolved (or retained) a lution to a behavioral problem that ars a close similarity to a solution rived at by similarly advanced ter- strial mammals, such as primates wolves, we may speculate that rhaps this may be the "best" solu- on. It may even be the only solution.

Consequently there is no aspect behavior in these animals that es not bear looking into closely. e have tried valiantly to confine ır quantitative behavioral studies iefly to communication, although cannot help but slip into some in- iguing qualitative or anecdotal aterial in areas other than com- unication. For three years we udied an undisturbed community mixed sizes and sexes of naïve ttlenosed dolphins at Marineland the Pacific. Recording sounds and serving concurrent behavior, we ere chained to the recorder and servation windows for the two- ur sessions we had assigned our- lves. Having also recorded at most the other major oceanariums in e United States—and presently in- stigating the dolphins at Marine- nd of Florida—if we hadn't picked a few anecdotal observations ong the way, we wouldn't be hu- an. Nor would this article be very teresting, particularly since we are rced to present data against one the best-loved myths that has isen about the dolphin—that of ıman-type language.

Dolphins are excellent subjects for mmunication studies, because so uch of their communication is cessarily conducted in one mode— und, the easiest area of communi- tion to study quantitatively in the boratory with tape recordings.

In the murky, aquatic environment inshore waters, the value of visual signaling is reduced to very short ranges, and we have seen only a limited amount of visual signaling in this species. Even these limited observations are subjective, and we hesitate to read much into them except for two clean-cut and consistent signaling systems: body position and relative speed of motion. Dolphins apparently lost the sense of smell when the nostrils moved to the top of the head to become the blowhole, and a sense of taste has not been demonstrated. Tactile stimuli must be considered, as dolphins employ them to a great extent, but the range of this type of communication is limited to actual contact.

The bottlenosed dolphin has two major types of sound emissions. The typical mammalian pulsed sounds, described by most authors as barks, yelps, squawks, or squeaks, are apparently emotional in context. They are emitted during episodes involving fear, protest, male sexual arousal, play, aggravation, and internal conflict. Similar to these pulsed emotional sounds are the pulsed, controlled emissions, which are utilized so beautifully in their astounding sonar system for habitat investigation. Unlike most other mammals, the dolphin has developed an additional pure-tone whistle emission. It is chiefly this whistle component that has led to the speculation that dolphins have a language. Some workers have postulated that different whistles are used in different contexts, as are words in a human language.

Now it would be reasonable to expect dolphins to have a limited number of different whistles, used in different contexts, as even the lowly insects and the birds have developed different songs indicative of different physiological states. Our results on naïve bottlenosed dolphins, as well as on other dolphin species, show, however, a remarkable lack of variability in the whistles emitted by a single animal, regardless of the conditions that have elicited them.

This sound, characteristic to each animal and different from those made by all other dolphins, obviously could serve to identify the animal and denote its location to other herd members. Whether isolated in a group, frightened, or just swimming about; in pain or protest; in air or water; the individual's whistle generally varies but little. The variations may include slight changes in frequency or speed of emission, or larger changes in rate of repetition and intensity, but it is almost always the same whistle and can be traced to a given individual. We have thus called this a "signature whistle." Whereas the minor variations are certainly capable of carrying generalized information to other members of the community regarding the level of arousal of the vocalizing animal, we have found absolutely no evidence indicating that the whistle has a true language content.

When an emotionally induced pulsed sound and the whistle are emitted simultaneously and repetitively as they frequently are, particularly in situations inducing pain or frustration, the information content is increased considerably. A herd member should be alerted to the fact that "Old Joe is over to my right and is pretty angry about something." The reaction of the other individual herd members would then probably depend pretty much on their past experience with "Old Joe." If his disposition is similar to that of most of the mature males that we have seen, the others will probably get as far away from the angry male as space permits. Conversely, a whistling infant, juvenile, or mature female may and frequently does attract approach and sometimes assistance by the others of the group.

There is a general tendency for a young animal's whistle to be less complex, in that each whistle is separated by a brief time interval from the next, whereas an older animal tends to make continuous signature

whistles. Also, infants and juveniles tend to whistle more frequently, and if newly separated from the herd, the whistling is almost constant. For the first few days after giving birth, new mothers also whistle almost constantly, thereby establishing the infant's early recognition of the maternal sound. The large males are usually the most silent in this regard, more frequently substituting direct action and jaw clapping for sound emission.

Whistling by one animal stimulates responses by others. One of the best ways to induce a tank of silent animals to vocalize is to add a noisy juvenile. There are good data for the common dolphin indicating that there is a tendency toward the inhibition of a response whistle until the termination of the first animal's whistle. Also, if two animals begin to whistle simultaneously, one may stop whistling abruptly until the first animal terminates.

Play occupies much of the time of the older infants and juveniles. Their exploratory activities are as yet largely uninhibited by the fear of strange objects that will overtake them in later life. The infants begin early to explore the other animals in their community. They make a quick escape from their mothers to swim with another female or juvenile, which has probably worked diligently at enticing the infant from the mother. Initially, the mother resists these escape efforts by giving chase to the fleeing infant; a chase apparently enjoyed by both the youngster and the successful individual that enticed it. The mother may become exasperated with too much of this and push the struggling, squealing infant out of the water for a few seconds, after which the recalcitrant returns to the mother's side. In our observations of mothers and developing infants, more experienced mothers allow more freedom to their offspring than do the primiparous females. An experienced mother, however, keeps a wary eye on her young, but doesn't swim to the rescue at the first squeal of a frightened infant. She directs her gaze toward the situation that has caused the squealing and goes into action to protect the infant when active interference seems indicated.

Curiosity, investigation, solitary play, and invitations to playful interaction continue throughout a dolphin's life, although these m[...] become somewhat reduced with a[...]vanced age. Even very old anima[...] however, will spend hours balanci[...] bits of paper or a small stick on the[...] snouts, flippers, or flukes, and in i[...]viting other animals to "try to ste[...] this if you can." The dolphin m[...] well be the only mammal, other th[...] man, that continues extensive play [...] adult life. The stealing of playthin[...] between dolphins is a frequent gam[...] in which no one gets angry, the orig[...]nal owner apparently enjoying tryi[...] to get them back. Disinterest or a[...]gression occurs more often if anoth[...] animal does not participate by tryi[...] to steal the object. Rather like do[...] and chimpanzees, dolphins appear t[...] seek out and enjoy a good tussle.

Sexual activity in the species is a[...] uninhibited and freewheeling as [...] their play. Male infants have ere[...]tions within a few hours of birth, th[...] erection precipitated by accident[...] brushing of the genital area again[...] the mother. Dolphins are necessaril[...] born in an advanced state of physic[...] development and body control, an[...] the males learn to copulate within [...] few weeks following birth. Earl[...] copulatory attempts usually are d[...]rected toward the mother, who is i[...] body contact with the infant muc[...] of the time. The mammary glands ar[...] located one on each side of the gen[...]tal area and doubtless serve to direc[...] the infant's attention to this are[...] Also the infant's nosing in this are[...] undoubtedly stimulates the mothe[...] Her response may range from passiv[...] acceptance to active solicitation o[...] the infant; solicitation is conducte[...] by nosing of the infant's genital area[...] which elicits an erection. The femal[...] then turns on the side, permittin[...] intromission. Only rarely have w[...] seen a mother actively reject an in[...]fant's efforts at copulation, but w[...] have one observation in which [...] mother became aggressive towar[...] her juvenile offspring, which ha[...] been persisting for about two hour[...] in its copulatory attempts. Rathe[...] than striking or biting the offender[...] she held him on the bottom of th[...] tank where he couldn't breathe fo[...] several seconds, a method that effec[...]tively dampened his ardor. Afte[...] learning to copulate with the mother[...] the infant solicits, and is solicited b[...] other females in the tank.

Genital self-stimulation is prac- ced by dolphins of both sexes in as ıany ways as the environment per- ıits. It is practiced more frequently y males, but we feel that this sexual ifference is not one of choice but f physical capability. The object of elf-stimulation may be animate or nanimate: large sea turtles kept in olphin tanks are a favorite object, ut even human divers have been inned against the tank walls by de- ermined males.

Male—male or female—female sex- ıal stimulation is practiced fre- uently. Relative ages or sizes of he participants of sexual interaction eem to pose no barriers. One species vill copulate freely with another.

Present data indicate that the fe- nales become sexually mature at pproximately seven years of age. Males begin to mature and are po- entially capable of producing off- pring at approximately the same ıge, but we are becoming convinced hat the much older males probably mpregnate most of the females in he wild. This conviction is based on estis size and motile sperm counts of nales of various ages. Probabilities, ased on sperm counts, are infinitely reater that a 20-year-old male will mpregnate a female with one copula- ion than that a 10-year-old would in everal copulations. The older bull as the additional advantage of reater size and experience, which ermits greater access to the females. There are also indications that, as he males go from the juvenile and dolescent stages to full sexual and hysical maturity, the incidence of elf-stimulation and biologically in- effective sexual activities decrease, o be replaced to a great extent, but ossibly not completely, by hetero- exual activities.

A complicating factor in studying exual behavior in this species is the eparation of "play," "sex," and 'aggression." These areas are much nore clearly defined in invertebrates and the lower vertebrates than they are in bottlenosed dolphins. The lines between these little behavioral boxes created by the human mind become very fuzzy in advanced mammals. One area fades into another both in word definition and in the actual temporal sequence of the animal's activity. Both dolphins and pilot

whales (as well as our own species) frequently engage in what appear to be fights between adult male and female, in which they give every indication of trying to kill each other. They swim at each other at full speed and bang heads so violently that the sound shakes the tanks and corridors; after this, however, copulation may occur.

The question of whether or how or when dolphins sleep is a potentially exciting problem area. Infants appear to fall asleep for brief periods even while swimming with their mothers, taking advantage of physical laws of hydrodynamics, which permit them to stay beside the mother without effort while she continues to swim. These same laws permit the infant to keep up with its mother if she swims rapidly for whatever reason. We have not managed to catch a juvenile when it appeared asleep, but a group of fat and satisfied old retired females at Marineland of the Pacific appeared to spend much time dozing at the surface. Until controlled brain-wave studies are conducted, observations have little to offer in this area, except to note that there appear to be vast differences between individuals in the time apparently spent "sleeping."

Everyone asks about dolphin intelligence. Frankly, neither we nor anyone else know much about it, but we will be glad to wallow around in the topic for a bit.

Quantitative tests of problem solving will have to take into account the fact that a dolphin's world is primarily a world of sound. Problem-solving experiments based on underwater adaptations of primate visual discrimination and oddity tests are not suitable for comparison. They should be modified to account for the dolphin's primary sensory mechanism of sound discrimination.

We have some doubts, also expressed by others, that dolphins are motivated highly enough by food rewards to make tedious repetitive tests as meaningful as they appear to be in such mammals as rats and sea lions. Subhuman primates will apparently work their hearts out for a few raisins, but we need better reinforcement than this for testing dolphins. On one occasion, since we have been working at Marineland of Florida,

one of the highly trained show animals ran full speed through her entire routine without waiting for or taking food rewards. The trainers, caught off guard, were kept running to keep the props exchanged fast enough. Although healthy dolphins usually have a healthy appetite, we have wondered at times if the bit of fish offered as a reward doesn't become mostly a symbol to the animal —a token of having done the correct thing. Some animals seem to work very well for a mere pat on the head from their trainer. An occasional animal has been reported to learn complex show tricks with no training or food reward. There seems to be no explanation of this except that it learned by watching the other performing animals, and that the learning of the tricks constituted the animal's only reward.

It must be emphasized here that there are extreme individual differences in learning ability in this species. All dolphin training is based on a system of rewards. Not even minor physical punishment is ever inflicted, so that motivation becomes an extremely important factor. Learning rate may therefore indicate a difference in problem-solving ability or it may indicate only bullheadedness (lack of proper motivation, if you prefer—"proper" meaning that the animal wants to do what the trainer wants it to do).

Occasionally, however, even a prized and beloved dolphin is subjected to some of the more unpleasant facts of life. Personally, we unhesitatingly include injections in this category, although we don't place them in as high a category as dental work. Dolphins regard injections as an abomination to be avoided at all costs. We therefore had a readymade situation for observing real problem-soving ability between individuals at Marineland of Florida when four animals in exactly the same physical situations, with exactly the same motivation, were receiving daily injections for about two weeks. In order to give the injections, it was necessary to get each animal from its large holding tank, through a latched gate, and into a shallower area where it could be handled with greater ease by the divers. It took the animals a day to

realize the implications of the arrival of several persons around the tanks, some carrying trays (filled with needles and syringes) and others in diving suits. The first day the animals came out on the usual cue used in the shows; the second day the fun and games began. There were two parts to the problem. First, if the animal could remain in its resident tank, it was safe. It was the winner. But even if it lost the first half of the game to the trainers (whose job was to get it out of the gate), it still had a second chance to escape the divers, who had to capture and hold it for the injections.

For two weeks, three of the four animals always tried flight as the reaction to being forcibly ejected from home base with a net. It always failed because they fled to the side of the tank farthest from the gate, where they could be netted and then brought easily into the shallow area where the divers waited. The fourth animal was more astute. She approached the problem head on by forcibly holding the gate closed. Dolphins are capable of exerting a tremendous amount of power, and there were times when the trainers came very close to giving up on ever getting the animal out. She not only leaned on the gate when it was closed and thus kept it from being opened, but if it happened to be open, she would get in behind it and force it shut despite the efforts of her trainer to keep it pulled open. Once she had forced it shut, she proceeded to lean on it again. Her tankmate never learned this behavior, but one of the animals in the adjacent tank showed a tendency toward it at about the time the series of injections ended, and this beginning was never carried to fruition.

On the second part of the problem —not being caught and held by the divers—one of the males was exceedingly adroit on the direct approach—that of bodily scattering divers to the four winds. This was brute strength, however, and not real problem solving by deviousness. However, it was difficult, after having worked with such an animal, not to read a look into his eyes, which seemed to say: "OK, everybody in place? Then here we go!"—and he proceeded to flip off as many as four or five divers, one at a time, in a very determined manner,

h each one being tossed, in turn, ›it farther as the over-all weight human flesh was diminished.

n this game there has to be, for Americans, the "good guys" and "bad guys." These games were ried on daily in full view of the ierican public, and there was never doubt as to who were the good s. They were the dolphins. The l guys were the people-trying-to-ch-the-dolphins. Over a period of eral years of watching this game, have never seen anyone pull for people.

ggressiveness displayed by cap-e adult males is a routine finding oceanariums, and personnel must on the alert for it. This is directed st clearly against maturing juve-e males, but both females and in-its are also subject to attack. This ght be thought of as a product of ›tivity, but for the frequent inci-ice of tooth marks found on wild aceans in which the tooth marks ›licate the dentition of their own ecies. There is one species. the sso's dolphin, or grampus, of Pelo-Jack fame, in which the body is isistently so scratched with tooth rks that for many years their atched appearance was believed observers at sea to be the innate oration.

Competition for food is pro-unced in the bottlenosed dolphin, much so that healthy animals ac-mated to oceanariums take turns lking sick animals to steal their ecial food. Of course these healthy imals sometimes get an overdose vitamins and antibiotics this way. We sometimes feel that bottlenosed lphins are as mixed up as people; having stolen another animal's ›d for days, they may then turn out and work themselves into a nzy, often going without food emselves to support physically the ne dying tankmate to keep it from ›wning. They also have been own to guide a sick animal around e tank, keeping it from bumping o the tank wall.

The bottlenosed dolphin is a fasci-ting and intriguing beast, both be-viorally and physiologically. There no need to reach out beyond fact find enough of binding interest keep both the research scientist d the layman happy for many ars to come.

A Man Apart *Continued from page 16*

ters—that he had to care for in the area of her husband's lineage. Obviously, Asanyi had disappeared. Nobody knew where he was, but they created plausible explanations.

I became inwardly incensed, thinking somebody ought to send for him so that the healing ritual could be carried ont, for I knew that nothing ritual could be done in Asanyi's absence. It was my servant, Asema, who set me right on that. So long as Asanyi was gone, he said, the local witches could not kill Dago'om with their *tsav*. Without the compound head's concurrence, Dago'om could not die. Since everybody knew that Asanyi was a frightened man who could never hold off all the witches in the community his absence was a good thing. My own position became absurd. I had no faith in the ritual they might perform for Dago'om, but I was put off that nobody did anything. It was inconsistent, and I knew it—and still felt somebody should do something. As I examined my own reactions, I soon discovered that part of my feelings of inconsistency and guilt came from the people in the community; it wasn't all a product of my Protestant upbringing. The community felt guilty.

Discovering anything about Dago'om, even genealogical information of the sort that Tiv usually give freely, proved unexpectedly difficult. I knew where he fitted into the standard genealogies, but it soon became evident that he was there by grace and not by right. Again, it was Asema who came to my aid. He told me that gossip had it—and he thought it was probably correct—that Dago'om had been born of a "sister marriage." This is a euphemism for a recognized and approved liaison between young people within the same lineage, who nevertheless do not share a common grandparent. Sexual relations between two grandchildren of a single individual are incestuous, but beyond that they are not. The requirements for marriage, however, are more strict.

A young man, whose name Asema never learned, had come over from the MbaShija segment, and had paid a goat to the mother of Dago'om's mother. He thereby got her permission, as well as the girl's, to "untie the shell" that, like all Tiv girls, she wore around her neck as a symbol of sexual non-availability. He had a right thereafter, recognized by the entire community, to sleep with the girl in her mother's hut, although she was too closely related for him to marry.

Dago'om's mother, then probably about fifteen, had been a fool, Asema said. She had refused to go to a husband when she became pregnant. She claimed that she loved this boy from MbaShija, and she was not going to take her baby someplace else and become the third wife of a repugnant old man. Her father tried to force her into the marriage, but she ran away from her husband's compound and came back to her own. He tried to convince her to elope with a suitable young husband who came courting. She refused and bore Dago'om "in her father's house." Dago'om thus became her "brother" rather than her son, and her father became his "father." Dago'om became a member, through a female link, of his own agnatic lineage. An even greater difficulty was that he had no "mother's lineage." His nickname—with which he had been taunted as a child—meant "God sent us an orphan."

I saw Dago'om five times in the next eleven days. Only once could I make any sense of what he said, although I recognized some words and my own name. Nege said that Dago'om talked nothing but foolishness now. Yet, about five days before he died—when I was again alone with him—he managed to break through his veil for about two minutes. He repeated to me with great urgency that since I was a guest in these parts and could not be harmed by the vicious people here, I must take all of his children and get them out of this compound, out of this lineage area, before they were all killed as he himself was being killed. The plea was interspersed with nonsense syllables, but I recognized that they were the kind of nonsense syllables that Dago'om sometimes muttered as he danced. Again I was struck with the cold fact that madness does not change us, it only makes us more so.

The only difficulty was that Dago'om had no children.

Or had he? Asema told me, when I relayed to him what Dago'om had said, that gossip told him Dago'om had had a love affair with one of

ısanyi's junior wives a few years go. Asanyi discovered it and banıshed Dago'om for several weeks. 'his woman bore a child that the en- re compound thought resembled)ago'om rather than Asanyi. Asema dded that the man who relayed this tory had agreed that the child did ıdeed resemble Dago'om. Although e tried to discover which of ısanyi's children was meant. we ever could. Asema did discover, owever, that Asanyi had made)ago'om give him a goat in settleıent of the matter and only then did e agree to help Dago'om get the ıoney for a wife of his own. Was it ıat child to which Dago'om might ave been referring?

Then one day the old mother of 'orbum, with whom Dago'om's wife ad stayed in our compound the night ıat he went mad, told me something lse. She said that her lineage sister ad borne Dago'om a child about a ear before, but it had died after only few weeks and almost surely the itches were involved because Dago'- m "didn't have anybody."

Dago'om sat mad, pitiably babling, losing weight, his potbelly alıost gone. his swollen scrotum like beach ball between his legs. Asanyi ayed away. Dago'om was an eldest ıild, even if he was not a legitimate ıild. Eldest children cannot be illed by the witches without the conırrence of the compound head. If sanyi stayed away, Dago'om's death ould not be laid to him. I understood ıis, but I still had pictures in my ead of the fine moots, which Tiv ıll "asking sessions," in which the nsmen of Dago'om would be faced ith his condition and asked why ey had allowed it to happen; why ey had not protected him from evil. thought perhaps they would call in baShija. the lineage of Dago'om's ınitor. But, day after day, nothing ıppened.

Then one morning Asema woke me th coffee and the news that Asanyi d come back. I rushed over to see m. He was pleasant enough, but ly said that he would have to rest day. Perhaps he could do someing tomorrow. I said that when he ent to a diviner, would he please let e know so that I could go along. sanyi replied laconically that he ould. He had nothing to hide, so he d not object if I saw what went on.

But the next day, Asanyi said that he had looked into his heart, and now thought the best thing to do was to forget the diviner and find a man who knew madness medicine and who would come to cure Dago'om.

When I talked to Dago'om that day, he had been moved into a reception hut. Nege told me that Dago'om had not eaten since the madness had descended on him. He was certainly thin and weak, but he sat up and seemed little changed.

That evening I went to Ukusu, where our base camp was located and where my wife was working. Just after dawn the next morning, I heard someone outside our hut calling my name. I answered. It was Anwase, who had come to tell me Dago'om had died in the night, and that they were going to bury him. Without shaving or even waiting for coffee, I rushed off with Anwase. The water was high and we had to wade through swamps up to our waists. When I entered our compound, Gu told me that Asanyi reported to him that Dago'om had struggled with death "on the ground," and that death had outwitted him. It was a standard Tiv metaphor of death—to struggle on the ground and lose. Yet, "on the ground" has a double meaning. When the term is used for marriage wards, it means that they have not been assigned to guardians, that they have no one in their natal lineages to protect them. Gu and Anwase assured me that it did not have this meaning here, but the image nevertheless seemed significant to me. Gu also volunteered the information that Ambu had been sent for. Ambu was the senior elder of MbaShija, the lineage of Dago'om's reputed genitor.

Anwase retired to his hut for a nap. Gu and I went to Asanyi's for the funeral preparations. The compound was almost empty when we arrived. Asanyi came out of his reception hut slowly and greeted us with the words, "Death defeated him." For almost two hours, nothing happened. Dago'om's wife was crying. She did not wail as widows are supposed to do, with ululations and long broken sobs interspersed with pentatonic phrases of funeral dirges all centering around the question, "Why have you left?" Rather she cried uncontrollably. Members of only three neighboring compounds came, nobody from farther away. When it was over, I asked Anwase why no Mba-

Shija had come. He replied with a trite phrase that I found chilling, "He wasn't theirs."

No questions were asked. No seating arrangements formed themselves for me to note. No moot to be settled. No wailing to be talked above.

Two youngsters from the compound carried the body outside under the direction of Nege, who had taken care of Dago'om since his return from the Yengev beer drink. A cloth had been spread on a bedframe made from the ribs of raffia palm leaves. The body, which had been covered with a thick layer of pale, imported talcum powder, lay on it. African corpses have a characteristic gray color. When the pink powder is added, they lose all human association. I had seen powdered corpses before here in the bush, and had assumed that it was done for cosmetic reasons since powder is often used that way by women. Dago'om's wife had been powdered the night before the beer drink. I nevertheless found it so repulsive that I could not believe it was true. I turned to Gu and asked him why the powder. He replied matter-of-factly that it cut down on the stink.

Without questioning or even caviling about who was to do what—an accompaniment of all other Tiv funerals I have seen—the time came to bury him. A grave had been dug along a path about a hundred yards from the compound. As they carried his body out, the women of the compound gathered around Dago'om's wife and wailed, but only for a minute or two and only out of kindness to her. The dirge was led by a leprous old woman, her hands almost gone, with a gritty but true voice, ululating, then singing in falling intervals, "Dago'om, why have you left us?"

It is a disgrace to his community if a Tiv goes to his grave without the wailing of the wives of his compound, and without the cause of his death being determined by its men—his fathers and brothers. These women—the wives of Dago'om's brothers—were keenly conscious of their own insecurity in a lineage in which such a death and such a burial could occur. In her short and raucous dirge, the old leper woman was seeing herself.

Dago'om's widow came along the path after us, approaching his grave as close as she dared—a Tiv woman who looks into a grave becomes barren. But the forces of life held h at a respectable distance.

The black topsoil had been throw to one side of the grave, and the rus red laterite below it piled on the oth side. The grave was about four fe deep, narrow at the top, with a she that made it wider below. The your men of the compound lifte Dago'om's body into the grave, whi the elders looked on. They pe formed no ceremony. Usually T sacrifice a chick at this stage of tl funeral ceremony, dripping blood c the chest of the corpse, sometimes c its nipples, and then throwing tl sacrificed chick into the bush as sign that the dead person is going t join the community of the dead. Th ceremony is performed, howeve only for men who leave living son Dago'om's children were either dea or not his own, according to Tiv belie

The two young men arranged hi body—"shoved it" would be more ac curate—into the shelf of the grave s that its head was to the southwes the "top of the country." They cov ered the shelf with a few pieces o wood, and got back up onto the sur face. The opening was covered ove with three logs. With a start I sa that one of the logs was the stocks i which Dago'om had spent the las three weeks of his life. I found it fit ting but melancholy. What more suit able way to get rid of it? On top o the logs they put a layer of thatching grass, then they piled on the topsoil. finally, the red subsoil was smoothec into the shape of an oval mound.

That was all. Gu put it precisely: "We have put him in the ground. That's all of that." Those who had washed him, prepared his corpse, and buried him accepted small torches of thatching grass from the oldest lineage member present. Each stood on top of the mounded grave and swung the miniature torch around his own head and feet (only some swung them around their trunks as well), changing hands with the burning grass. Each then dropped his torch onto the mound and backed off. This ritual was to "gather up the dreams" so that no one would be haunted, so that no one's luck would "close up on him."

Walking home with Atsegher and Gu, I was tense. Tiv funerals usually provide a catharsis for everybody present, including the ethnographer. But not so with Dago'om's. I felt that

something should have happened, that somebody ought to have done something. I felt an intense desire to stir them up. But I, too, did nothing.

Back in the compound, Asema asked me what had happened: he had chosen not to attend. I told him, and wondered whether Dago'om had had the medicine that caused his madness administered to him at the beer drink in Yengev. Asema said he thought it unlikely, because madness medicine is a very powerful substance and is usually administered by your brothers or your wife spreading it on the thatch over the entryway to your hut. The dangling ends of the thatching grass stroke your back as you go in and out, the medicine enters your body, and you become mad. When I tried to tell Asema about my feeling of unfulfilled tension, he asked, "But did they beget him?" It was another way of saying, "He wasn't theirs."

Dago'om "had nobody." He "sat alone," and there was no one to avenge him when he was dead any more than there was anyone to protect him when he was alive. He was expendable.

Two weeks later, the rains had reached their peak. I heard that Dago'om's mother had arrived at Asanyi's, but the bridge over the Anu river was three feet under a rushing torrent of water. A few Tiv chose to cross it—I did not. I also heard that his wife's mother had come for her daughter and had taken her home to Ga'ambe where she would have a better chance of forgetting Dago'om and of going to another husband. I asked whether anyone at Asanyi's would inherit her. Anwase said that while somebody could go to try to collect the bridewealth that had been given for her, he thought it unlikely that anyone would or that they would take the woman. They would, Anwase finished, forget her. He suggested that I might want to talk to Dago'om's mother about that. A few days later, when the bridge was again passable, I went to find her. Nobody knew where she had gone.

Nothing ever happened. A man was expendable. He went mad and died. The Tiv were uncomfortable about it, ashamed of it, and quickly forgot it. It took me longer because my culture will not admit that anybody is expendable, whatever the "facts" may be and whatever our techniques for doing the same thing.

The Wildlife Conservationist's Library

by Durward L. Allen

A recent wildlife book that came to my desk, *Of Predation and Life,* by Paul L. Errington, exemplifies a kind of biological work that bridges a wide field of reader interest. Of course, a book about the realities and dynamics of bloodshed in the natural world has inherent interest and this one is concerned not only with "who done it" but why. Errington probably knew the answers better than anyone else. The story is told with detachment and in casually colorful language. The book appeared five years posthumously, but its scientific and literary qualities honor its author and also his wife, who edited the rough manuscript and brought it along to publication.

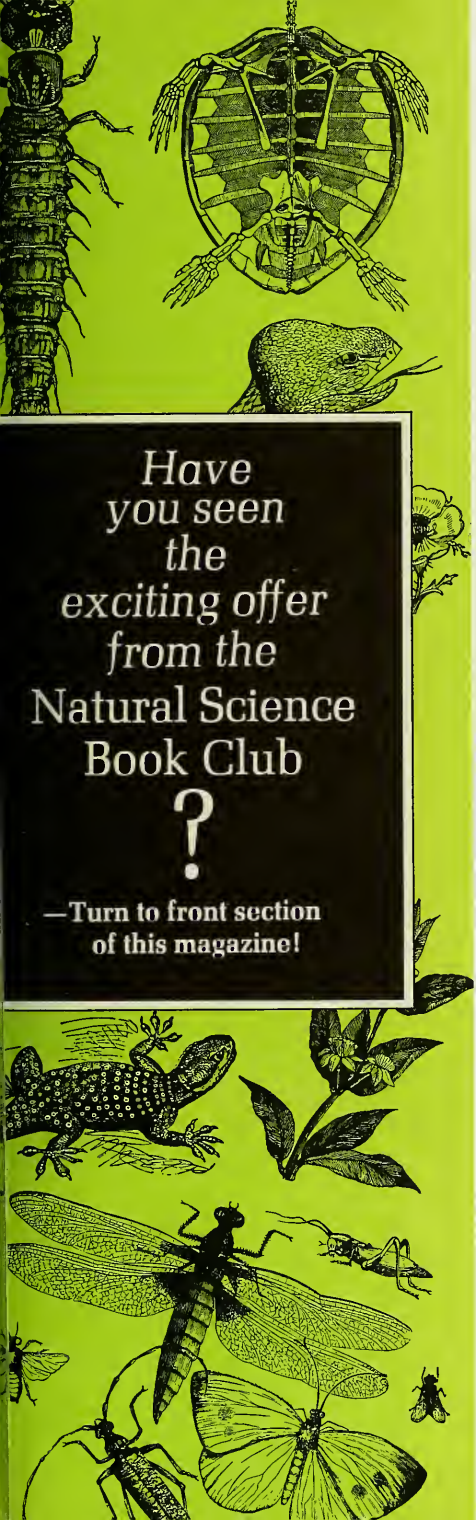
Critical to the broad usefulness of such a work is its freedom from specialized jargon and tedious documentation. This does not impair its value as a synthesis and summary for the professional, and most significantly, the treatment is eminently right for a key figure in today's parade of resource issues, the citizen conservationist.

I have conceived a great respect for this person, whom we might call the self-educated amateur in wildlife science. I suspect that nothing is going to go well without his attention. He is an abiding comfort to the frustrated professionals. Sometimes he is so motivated by intellectual curiosity, social responsibility, and old-time cussedness that he will persistently search out obscure facts and then hang on until something worthwhile is done. His favorite literature is the durable kind, certainly nothing to lure the TV audience into contemplative quietude.

Of Predation and Life deals with an elusive and misunderstood subject and is a book I shall recommend to those who inquire, "Where can I get good, summarized information on wildlife and how it should be managed?" I have already been suggesting other books by Paul Errington, *Of Men and Marshes, Muskrats and Marsh Management,* and *Muskrat Populations.* They are the kind of masterwork that forms the core of a wildlife bookshelf for both professional and amateur. But what else would we find there for wildlife conservationist who is lar interested in vertebrate animals—m commonly birds, mammals, and fi and the many kinds of benefits that manity derives from them? Wild preservation and management are derstood and achieved through a kn edge of ecology, or environmental b ogy. The entire field is so broad it mi include books in almost any phase life science or earth science, and far yond. Commonly the conservatio enjoys a special knowledge of s group of living things readily access to him—birds, insects, trees, mu rooms, or perhaps, marine mollu His working books will include gui and handbooks accordingly.

Necessarily, the wildlife amate library is influenced by the own age, and features titles that could obtained while they were in print available at modest prices. Today, example, a wide area of natural hist and ecology is covered by the "L Nature Library" and McGraw-Hi "Our Living World of Nature" ser Readings of this kind are the und girding of sound viewpoints on m agement and conservation. The natu history background a reader of thi years ago got from Seton's great wo is now available in such sources Cahalane's *North American Mamm* *The Wild Mammals of Missouri,* Charles and Elizabeth Schwartz, a *American Game Birds of Field a* *Forest,* by Edminster.

When enlightened state conser tion commissions give qualified peo time and support for a creative j great things can happen—the sub dized Schwartz volume quickly beca a best buy for every alert wildlife e thusiast, as did *Iowa Fish and Fishin* by Harlan and Speaker. Current sub dized books having a well-deserved, a tive sale from the Superintendent Documents are the Bureau of Spo Fisheries and Wildlife publication *Waterfowl Tomorrow* and *Birds in O* *Lives.* Two of the newest books on gam birds are Sheldon's *The Book of th* *American Woodcock* and The Wildli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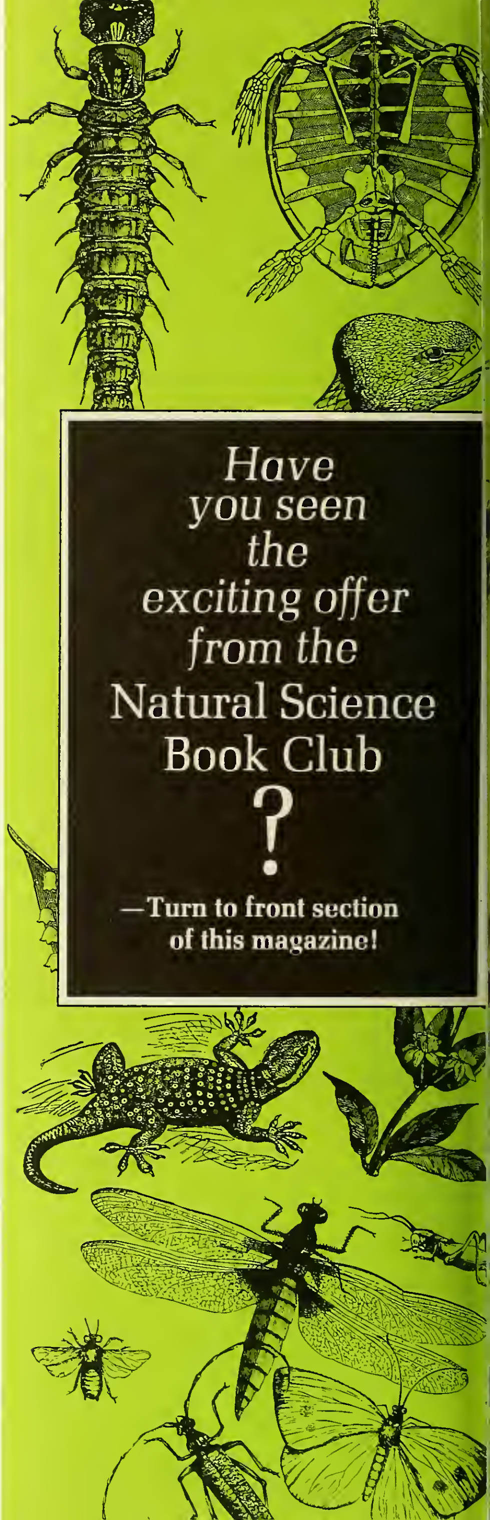
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Society's compilation, *The Wild Turkey and its Management.* The latter is a successor to books on this species by Mosby and Handley (*The Wild Turkey in Virginia*), Latham (*Complete Book of the Wild Turkey*), and Schorger (*The Wild Turkey: Its History and Domestication*).

The study of wildlife communities has seemingly endless ramifications. and one area of outstanding progress is behavioral science. Classics of their kind are Darling's *A Herd of Red Deer* and Tinbergen's *The Herring Gull's World.* Schaller's captivating account of *The Year of the Gorilla*, Lorenz' *On Aggression*, and Ardrey's *The Territorial Imperative* are fine reading for anyone curious about animal society. Behavior must be of concern to conservationists. since it is intimately involved with community relationships and the supporting capacity of habitats.

It is to be expected that as the amateur wildlife student enlarges his horizons he will want older works in the field. For these he must scan the lists of secondhand dealers. This is essential if he is to have a well-rounded picture of wildlife science, which has blossomed gradually in the past 40 years. The earliest solid landmarks of management are acknowledged to be Stoddard's *The Bobwhite Quail: Its Habits, Preservation and Increase* (1932), and Leopold's *Game Management* (1933). These opened an era that has been highly productive of studies on the habits, environmental relationships, and management of vertebrates. As might be expected, sporting species have had special attention owing to the availability of funds for solving management problems.

Historical accounts are to be especially recommended not only for their color and interest but also for placing today's problems in the proper context. A reference to the original status of many wildlife species is Burroughs' *Natural History of the Lewis and Clark Expedition.* More specific to the conservation idea as it developed in this century are three books that nicely complement one another. Pinchot's *Breaking New Ground* is concerned primarily with forestry, but it is our best account of those critical events of the first decade, presided over by Theodore Roosevelt. Pearson's *Adventures in Bird Protection* reviews the vicissitudes of legislative progress and the establishment of the Audubon movement. A book sponsored by the Boone and Crockett Club, Trefethen's *Crusade for Wildlife*, makes a single story of our conservation efforts from the creation of Yellowstone National Park in 1872 through the first half of this century.

Highly pertinent to the preservation of all wildlife is the fate of extinct or

endangered species. This aspect of our outdoor past and present has been treated in many sources, but especially well in Audubon Society publications on the roseate spoonbill, whooping crane, ivory-billed woodpecker, and condor. Schorger's *The Passenger Pigeon* and Roe's *The North American Buffalo* are valuable references on two unique American species.

The most definitive work on waterfowl management is Day's *North American Waterfowl*, as revised. Periodically, valuable contributions have been made to waterfowl ecology and behavior, notably Hochbaum's distinguished *Canvasback on a Prairie Marsh* and *Travels and Traditions of Waterfowl*. The wildfowl hobbyist will collect, as he can, Bennett's *The Blue-winged Teal*, Pirnie's *Michigan Waterfowl Management*, Sowls's *Prairie Ducks*, Mendall's *The Ring-necked Duck in the Northeast*, Wright's *High Tide and an East Wind*, and Hanson's *The Giant Canada Goose*.

State publications have been particularly significant in dealing with species of high economic importance. New York's tome on *The Ruffed Grouse* by Bump, Darrow, Edminster, and Crissey remains the most ambitious effort of its kind. *The Sage Grouse in Wyoming*, by Patterson; *Wisconsin Grouse Problems*, by Grange; and *The Whitetailed Deer in Wisconsin*, by Dahlberg and Guettinger are hard-backed books of general value.

The Wildlife Management Institute has sponsored a long list of wildlife books, including such titles as Einarsen's *The Pronghorn Antelope and Its Management*, Olaus Murie's *The Elk of North America*, and multiple authorship compilations on *The Deer of North America* and *Pheasants in North America*. Especially notable are the books on predators by Young and his collaborators: *The Wolves of North America, The Puma: Mysterious American Cat, The Bobcat of North America*, and *The Clever Coyote*. Other works on these carnivores are Wright's *The Ghost of North America: The Story of the Eastern Panther*, and two bulletins in the "Fauna Series of the National Park Service," Adolf Murie's *The Wolves of Mount McKinley* and Mech's *The Wolves of Isle Royale*. A delightful cultural work in a class by itself is Dobie's *The Voice of the Coyote*.

Among meaningful general treatments of conservation problems and management systems are Gabrielson's *Wildlife Conservation, Wildlife in Alaska* by Leopold and Darling, *African Game Ranching* by Dasmann, *The Quiet Crisis* by Udall, and Aldo Leopold's philosophical essays in *Round River* and *Sand County Almanac*.

This short review must be considered a suggestive sampling of the field, since

ıany excellent works have not been ıentioned. The inquiring reader will ıake discoveries of his own—which dds to the charm of an avocation that ; also an important social enterprise.

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)AWN OF ZOOLOGY, by Willy Ley. *'rentice-Hall, $7.95; 280 pp., illus.*

Historians with an interest in science, and scientists grown old nough to gain respect for the history f their profession, have tried, on many ccasions, to sort out and trace the evelopment of ideas. Their task has lways included helping their readers nderstand the context of past beliefs nd the slow transformation from a haos of misunderstanding and supertition to the present spectrum of hyotheses and facts extending from the lectron to the cosmos. Essentially, this mounts to describing the ecological etting as it evolved during more than ıirty-five centuries, always with man t the center of the stage.

Willy Ley has made this developıent evident in the headings of his ine chapters: Man the Hunter, the hinker, the Collector, the Allegorizer, the Cleric, the Reformer, the Systematizer, the Digger, and the Explainer. He takes the first eight chapters to reach the year A.D. 1811, leaving everything more recent than 1872 to a brief epilogue and to the reader who has followed this far. The publication of *Origin of Species* seems to be the sunrise he had in mind in choosing the title for the book.

The early history of man's study of animal life holds a special fascination when it is fitted into more familiar information about the rise and fall of empires, the shifting centers of culture, and the progressive extension of awareness among Europeans of peoples and creatures in other parts of the world. It always astonishes us how much we assume, incorrectly, that the past was so like the present. The dogs of the Bible, for example, were the same kind of animal as the familiar dogs of today, but they were "only semidomesticated then; nobody in the Bible owns a personal dog." Attitudes toward dogs differed correspondingly in biblical times. Just as surprisingly, "the cat is not mentioned in the Bible" at all. Knowledge of animals that impinged less frequently upon mankind remained fragmentary until quite recent years.

Much of the subject matter covered in *Dawn of Zoology* matches material in previous histories of biology and of science. The lives of many of the men mentioned, even some quotations from their books, will be familiar to anyone who has been steeped in the "survey" of such history by Erik Nordenskjold, Charles Singer, or George Sarton. Yet the thoroughness of scholarship for which Willy Ley has become famous and respected shows through in the marked differences. *Dawn of Zoology* makes no attempt to trace the development of medicine; it makes no mention of Galen or Vesalius or William Harvey. Robert Hooke earns a place for his posthumous remarks about the nature of fossils, but his microscope and the discoveries he made through it are omitted, as are his contemporaries Leeuwenhoek, Malpighi, and Swammerdam. On the other hand, Ley finds fascinating dissimilarities among the various editions and translations of the old classics, and suggests reasons for the cutting and trimming done to match audiences in diverse nations.

Readers will particularly enjoy his comments about the Sicilian emperor Frederick II, who led the Sixth Crusade and ranks among the very few in history who managed to get excommunicated three times! Ley also offers some unfamiliar details about the naturalist nun Hildegard of Bingen, which clearly show her contributions to the expansion of knowledge during the

Dark Ages. Francis Willughby takes on more importance in relation to the work of John Ray, and Pierre de Maupertuis gets credit for almost discovering the laws of heredity and the existence of genes from his account, in the mid-1700's, of the inheritance of six fingers and six toes through several generations of a human family. The significance of Robert Chambers' 1844 book *Vestiges of Creation* becomes evident in the evolution story, and the French missionary Père Jean Pierre Armand David wins appreciation for his efforts to make known to science not only "Père David's deer" (the mi-lu) but also the snub-nosed monkey and giant panda.

Woodcuts and other illustrations from old books add greatly to the flavor of *Dawn of Zoology*. In most cases, the captions indicate the source as well as the significance of the animal depicted. Readers who would like to explore topics of special interest further can refer to twenty-two pages of notes, where additional information and some choice comments are included.

Someone has said recently that the history of a subject is seldom written in detail until the area of study is already moribund. This book gives no such feeling, for it ends on a breathless note, readying the reader for an account of the explosive radiation in zoology following the appearance of *Origin of Species*. We can only hope that Willy Ley will turn his remarkable abilities toward putting in comparable perspective these developments of the past century.

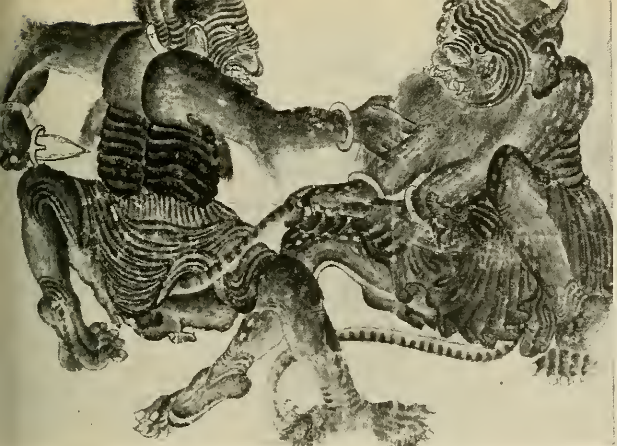
Lorus and Margery Milne
University of New Hampshire

Shamanism: The Beginnings of Art, by Andreas Lommel. *McGraw-Hill Book Co., $12.00; 175 pp., illus.*

Andreas Lommel, Director of the National Museum of Ethnology, Munich, examines the phenomenon of shamanism in relation to its role in the functioning of those societies of which it is, or was, a part, especially in relation to its influence on the origin and development of art.

It is an intriguing, provocative, entertaining work, with enough expression of attitudes foreign to my approach to the subject to make me re-examine some of my understandings in several areas discussed by the author.

To Lommel, shamans are persons who always perform healing functions in particular (and other functions on occasion) while in a trance. One must assess Lommel's ideas in light of this frame of reference, a frame different from mine in which I see the trance-



Two fighting demons depicted in a fifteenth-century Turkish manuscript, above, and a late eighteenth-century Shaman's coat from the Tungus of Siberia, left, are two illustrations from "Shamanism: The Beginnings of Art."

›rking shaman only as a special sort ‹ shaman.

The author's thesis is that shaman-ln is associated primarily with hunt-ig societies and developed because of ›belief that every living creature has lth a physical and a spiritual being ›d that special people, the shamans, ‹n penetrate the spirit world. The ›nder-worker acts to heal, to assure lnting success, to increase the fer-tity of women, and to perform other ›eded tasks on a personal or a com-ınity level by means of the influence ›d power he draws from his associa-tn with the spirit world. I'll not quar-ı with this, nor with the fact that the shaman's ritual often results, or seems to result, in the desired effect.

It is possible in view of the evidence Lommel cites, and the manner in which he uses it, to accept his idea that the shaman was the first artist. Lommel sees in a shaman's trance performance and in his spirit-world-directed actions, a man performing the roles of sorcerer, poet, artist (in the sense of painter or sculptor), and dramatist all at once upon occasion, separately at other times. We cannot go back to the beginnings of shamanistic activity among our ancestors at the dawn of human culture, and it is an ever chancy business to interpolate modern primitive activity and world view with that remote past. Nevertheless, Lommel's effort to penetrate the thought processes that permitted shamanism to develop, by assessing them in terms of modern and recorded shamanism, is worthy of applause. His modern references include Eskimos, Australians, Central Asians, American Indians of the Northwest Coast, among others. He does a good job.

I'd quarrel with some of his assertions. I do not believe, for instance, that X-ray animals were necessarily drawn as ritual magic to restore life to dead animals. I'm sure such drawings were often made as forms of sympathetic magic to bring luck in hunting. I doubt there was much influence of shamanism on classical art. I am not convinced that central Asian X-ray

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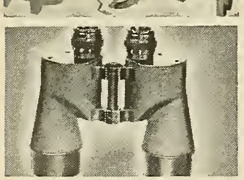

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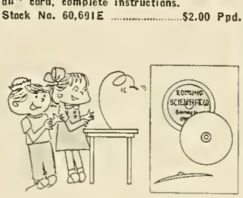

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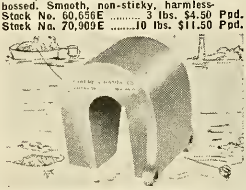

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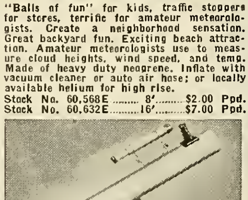

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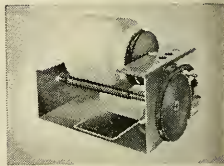

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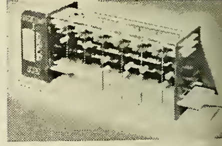

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drawing styles were influential in Indonesian art. There are several such sweeping and, to my mind, unproved assertions in the book.

One aspect of the presentation that annoyed me was that the illustrations were simply pictures, interesting and instructive, perhaps, but not supplementary to the text except in the most remote way. On the other hand, the commentary in the list of plates is excellent. So is the bibliography.

The book is worth knowing.

JAMES L. SWAUGER
Carnegie Museum

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THE POPULATION BOMB, by Paul Ehrlich. *A Sierra Club-Ballantine Book. Ballantine Books, Inc., 95¢; 224 pp.*

It is not generally considered polite to rush into someone's house and shout at him. It is not often that one finds a scientist, whose subculture calls for cautious statement and measured diction, roaring like an Old Testament prophet. A justification for the first impropriety is that the house is burning down, and for the second, that the world is in worse trouble than we thought.

Early in this short, relentless book, Dr. Ehrlich makes a distinction between understanding the population explosion intellectually and understanding it emotionally. Indeed, we all know there is a population explosion. Most of us either ignore it, or hope that it won't be as catastrophic as some writers say it will be. But reader's of this magazine who say "I've read all about that," or "Another book on population?" and move on to something else do so at their own risk. For the message of this book is that there is no refuge.

Brilliantly and at white heat, Dr. Ehrlich knifes through much of the nonsense that has been written by optimists and explains that, no matter what is done, the future will be bad—for everyone. His major points were published in these pages last June in "The Coming Famine." In this book

he expands on those points. This is not a book of terrifying and finally mind-dulling statistics. It is a personal, needling book that realistically analyzes the options available to us and makes the reader understand *emotionally* what, within these options, we all surely face. Unlike many books on the subject, it devotes almost one-fifth of its pages to what you, a private citizen, can do about the situation. And surprisingly, there is still a great deal you can do. One thing would be to join Dr. Ehrlich in becoming a "part-time propagandist": get a copy of this book, read it, and pass it on.

For if enough people don't get busy, the world will not just be an unattractive place for everyone who manages to survive: it may be that natural history (which is another phrase for the study and celebration of life) will become an antiquarianism.

J.K.P.

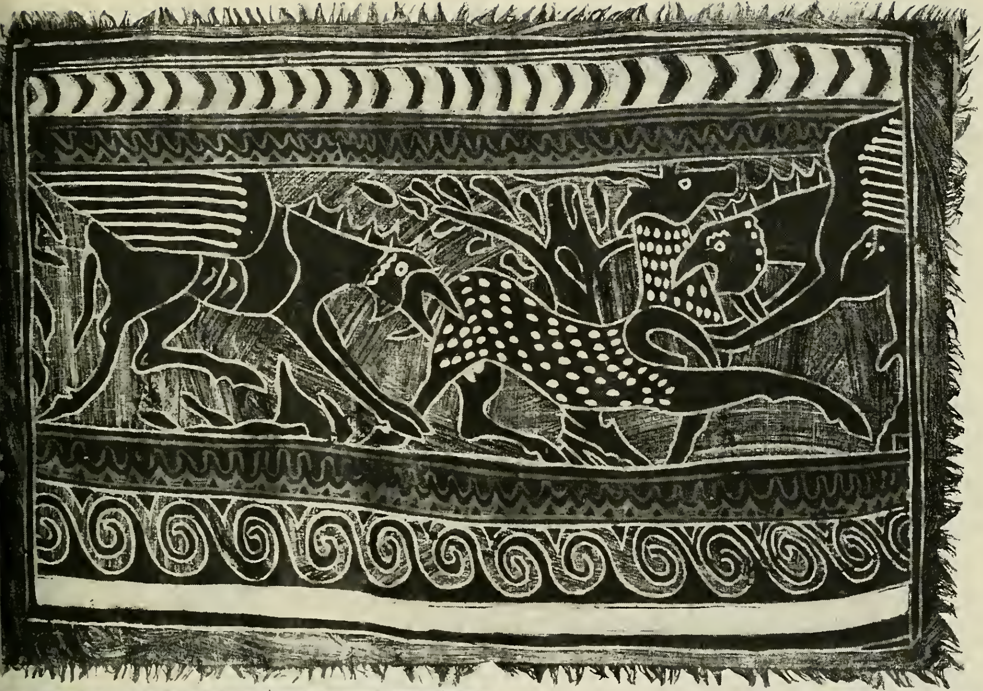
Briefly Noted:

THE SANDY SHORE, by John Hay. *Chatham Press. $2.95; 64 pp., illus.*

Curious beachcombers will welcome this small guide to the sandy shores of Cape Cod. Inexpensive, portable, and clearly written, it conveys the beauty and diversity of the many marine plants and animals adapted to survive in the harsh environment of an unprotected shore. Mr. Hay hopes his book will encourage the visitor "not merely to look and leave, but to stop and look again." Accordingly, he describes in detail the residents of the beach—from the lowly sand flea to the graceful shorebirds—stressing the delicate balance between animal and environment. The text is complemented by precise color and black-and-white drawings, and while the book is specifically about Cape Cod, it can be used for any shore area from New Jersey to Maine.

VANISHING TRIBES, by Roy Pinney. *Thomas Y. Crowell Co., $7.95; 272 pp., illus.*

Roy Pinney, who in the past has been concerned with vanishing wildlife, has now turned his attention to vanishing people—those primitive tribes who are either being absorbed into the mainstream of civilization or are simply dying out. One can lament that future generations will not see a living passenger pigeon, dodo bird, or kiwi, but the same may soon be true of numerous tribes around the world whose only proof of cultural existence will be some artifacts in a museum and a chapter in a book such as this. While few groups of men have, as yet, actually become physically extinct, Mr.



A

B

Pinney feels that the loss of culture is the main problem of many tribes of the world. In this book he details the present state of thirty-three threatened tribes in what may well turn out to be their obituary.

THE FITNESS OF MAN'S ENVIRONMENT, Smithsonian Annual II. *Smithsonian Institution Press, $5.95; 250 pp.*

This volume is another to be added to the increasing flow of literature expressing anxiety over man's destructive alteration of his environment. Twelve essays have been assembled from a variety of contributors—a biologist, an anthropologist, an architect, etc. From Paul Goodman's desire to guarantee freedom *from* excessive social engineering to Philip Johnson's assertion that a complete change of values is needed to build beautiful cities, these indictments of the present and suggestions for the future make lively reading. One can't help wondering, though, when analysis will end and action begin!

DINOSAURS-AT HOME, by Theodore E. White. *Vantage Press, $5.00; 232 pp., illus.*

Despite its title, this book is not a manual on the care and feeding of dinosaurs. The "at home" refers to Dinosaur National Monument, and the author, a paleontologist, attempts to anticipate and then answer the layman's questions about these prehistoric reptiles. If you can overcome the unattractive format of the book and the cliché-ridden prose (hearts leap, spirits remain high, ideas are half-baked, and visitors increase by leaps and bounds) you do eventually dig down to some solid information on dinosaurs.

C. B.

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Suggested Additional Reading

A MAN APART

RETURN TO LAUGHTER. E. S. Bowen. Harper & Brothers, New York, 1954.

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POLAR BEARS AND THEIR PRESENT STATUS. C. R. Harington. *Canadian Audubon Magazine*, January-February, 1964.

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MAN IN THE EVERGLADES. C. W. Tebeau. University of Miami Press, Coral Gables, 1968.

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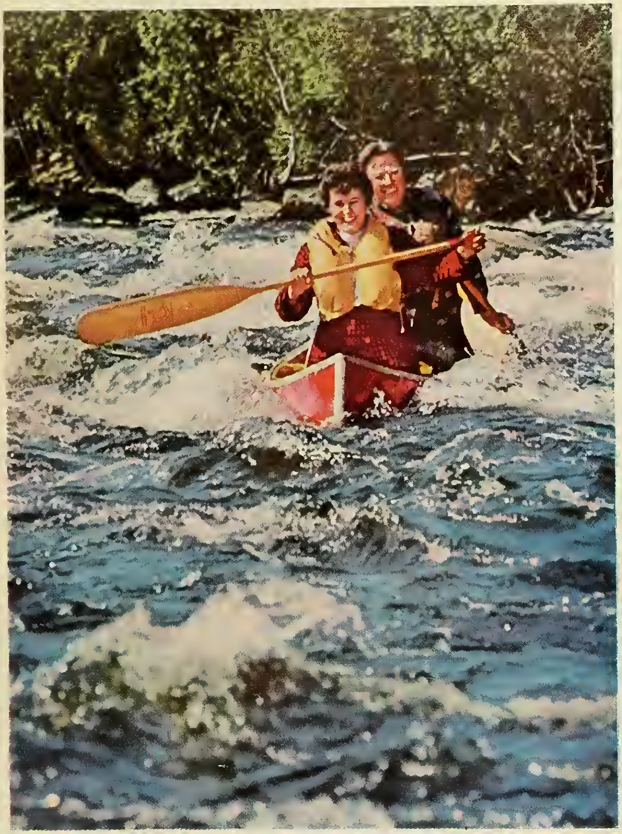

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Then the utility company entered the picture. From a study of its own, it declared the dam uneconomical and detrimental to natural resources. So Governor King asked the conservationists, under Bofinger's leadership, to plan for the valley's permanent protection. The river was safe.

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THE AUTHORS

Arthur D. Hasler is an ecologist and an authority on eutrophication, the process of lake aging. Author of more than 100 articles on limnology, fishing science, and animal behavior, he also originated the theory that salmon return to their home stream to spawn by identifying a dilute odor characteristic of that stream only. Dr. Hasler is now Professor of Zoology and Director of the Laboratory of Limnology at the University of Wisconsin. In addition to fishing, he finds diversion playing the French horn in the Madison Symphony Orchestra.

Coauthor with Dr. Hasler of this month's article on lakes. Bruce Ingersoll has been a lumberjack in the forests of Washington's Olympic Peninsula, a guide for fishermen in Wyoming and Minnesota, and a civil rights and crime reporter for the *Chicago Tribune.* He is now working for his masters degree in conservation communication at the University of Wisconsin.

A lifetime of studying and sculpting animal motion and musculature gives Lewis S. Brown ample background to discuss "The Right Way to Walk Four-Legged." He received a degree in fine arts from Pratt Institute in 1931. and since that time has contributed animal sculptures and drawings to such institutions as the West Point Museum and the Hall of Fame of the Trotter, Goshen. New York. He has also taught comparative anatomy at Pratt, and has written and illustrated several books and papers on anatomy. Mr. Brown is Senior Technician in the Department of Anthropology at The American Museum of Natural History.

Howard E. Evans. author of the article on fireflies, began studying insects as a child on a tobacco farm in the Connecticut Valley. This early interest led to a Ph.D. in insect taxonomy at Cornell and a distinguished teaching career. Dr. Evans is at present Curator of the Department of Entomology at the Museum of Comparative Zoology, Harvard. His most recent book, *Life on a Little-known Planet* (E.P. Dutton & Co., 1968), from which his current contribution to Natural History is excerpted. follows two scholarly studies and one popular book, *Wasp Farm*, which Natural History Press published, and which was a candidate for the National Book Award in 1963.

William Irons' article is the result of a total of 18 months of research in Iran in 1965. 1966. and 1967. His work was sponsored by the Foreign Area Fellowship Program and the University of Michigan Center for Near Eastern and North African Studies. Mr. Irons expects his Ph.D. from Michigan this month, after which he plans to go to Afghanistan for a year to continue his anthropological research. He has published one article, "Livestock Raiding Among Pastoralists: An Adaptive Interpretation" in the *Papers of the Michigan Academy of Science, Arts and Letters*, 1965.

Jack Hope. senior editor of Natural History, has contributed two articles to this magazine (August-September, 1967, and February, 1968) both dealing with parks. His latest effort. concerning Mineral King National Game Refuge, is the product of exhaustive research, which took him from Washington, D.C. to Los Angeles. from Disneyland to the High Sierras.

Anthony F. C. Wallace, coauthor with Virginia L. Lathbury of this month's article on beavers, is Chairman of the Department of Anthropology at the University of Pennsylvania. Dr. Wallace contributed the essay "Psychological Preparations for War: Techniques and Consequences," to Natural History's special supplement on the anthropology of war (December, 1967). He is also author of *Culture and Personality* (1961) and *Religion: An Anthropological View* (1966), both published by Random House.

Mrs. Lathbury spent nearly three years observing and photographing beavers and their constructions. The mother of four grown children, she is now working on her masters degree in anthropology at the University of Pennsylvania.

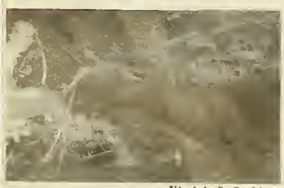

Arthur D. Hasler


Bruce Ingersoll


Lewis S. Brown


Howard E. Evans


William Irons


Virginia L. Lathbury


Anthony F. C. Wallace

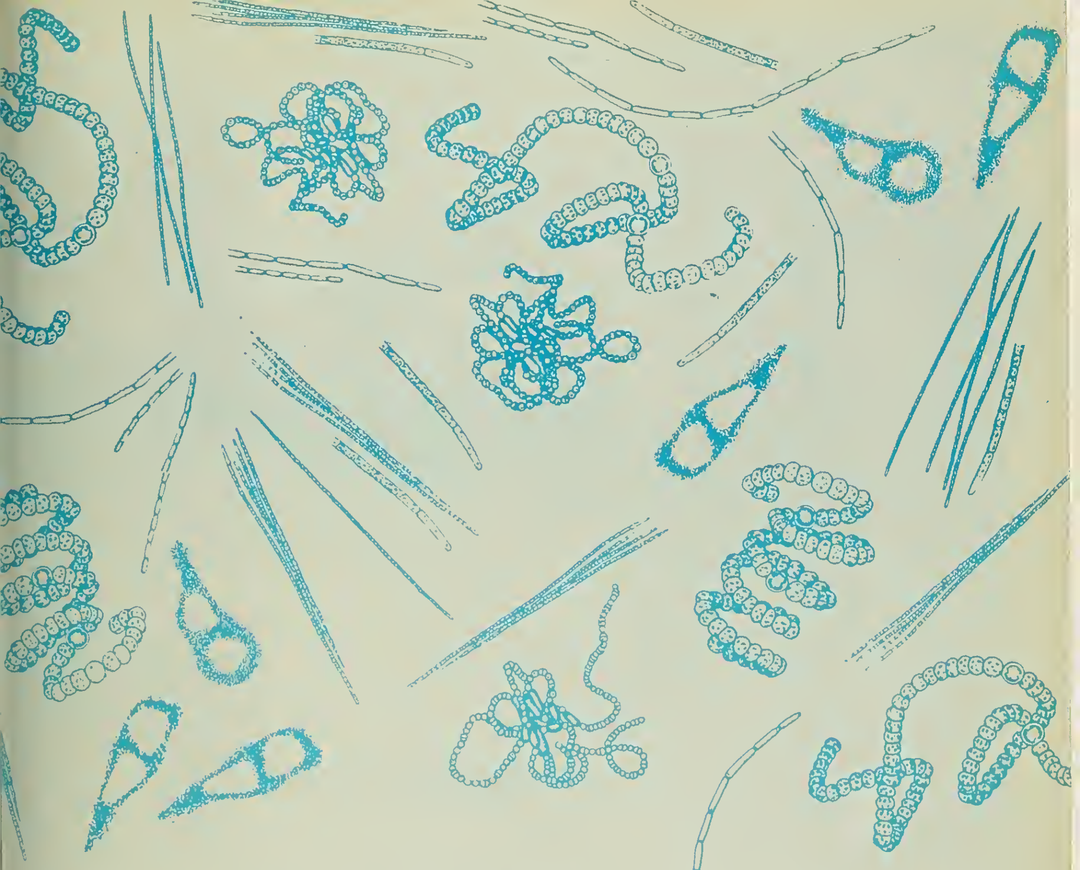

Jack Hope

Dwindling Lakes

Blue-green algae cause the natural aging and disappearance of lakes. Man hastens the process.

Algae, minute and one-celled, ride the summer waves of every waterway in America. They colonize stagnant sloughs of rivers and gather in backwaters behind dams. Under a microscope, these tiny and rather attractive plants appear innocent enough, yet they can quickly cover a bay with scum, form hairy filaments to enslime a rocky shoreline, or clog an entire lake. With life-spans of only a few days, algae can make any lake grow old thousands of years before its time.

To realize their immense potential for harm, however, algae depend on



an. It takes man to speed up natu-
l eutrophication, the normal proc-
s of enrichment and aging under-
ne by bodies of fresh water. By
rtilizing the nation's waters with
e nutrients vital to algae growth
d reproduction, primarily nitrogen
d phosphorous, we turn eutrophi-
tion into an accelerated, cultural
ocess—cultural in that we are per-
rting nature with municipal sew-
e, industrial wastes, agricultural
ainage, and other odious by-
oducts of our civilization. Cul-
ral eutrophication, therefore, is an
erration: a natural process run-
ng amok.

In enriching the water with the
trients in sewage, groundwater,
d urban and rural runoff, we pro-
te the exponential reproduction of algae: the seemingly harmless alga becomes 2 algae, then 4, 16, 256—multiplying until there are billions. And during such a population explosion, lakes become murky and fetid under the August sun, while wave-tossed weeds, bloated fish, and dead algae rot in shoreline windrows.

More than one-third of America's 100,000 lakes are showing signs of cultural eutrophication. The danger of accelerated eutrophication continues to grow as our population makes greater demands on national water resources, and lakes continue to take on the eutrophication syndrome. Besides showing the symptoms of excess nutrients and algae bloom, they are characterized by the depletion of dissolved oxygen in deeper waters, a change from cold-water game fish to "rough" bottom feeders, and the encroachment of rooted vegetation from shore.

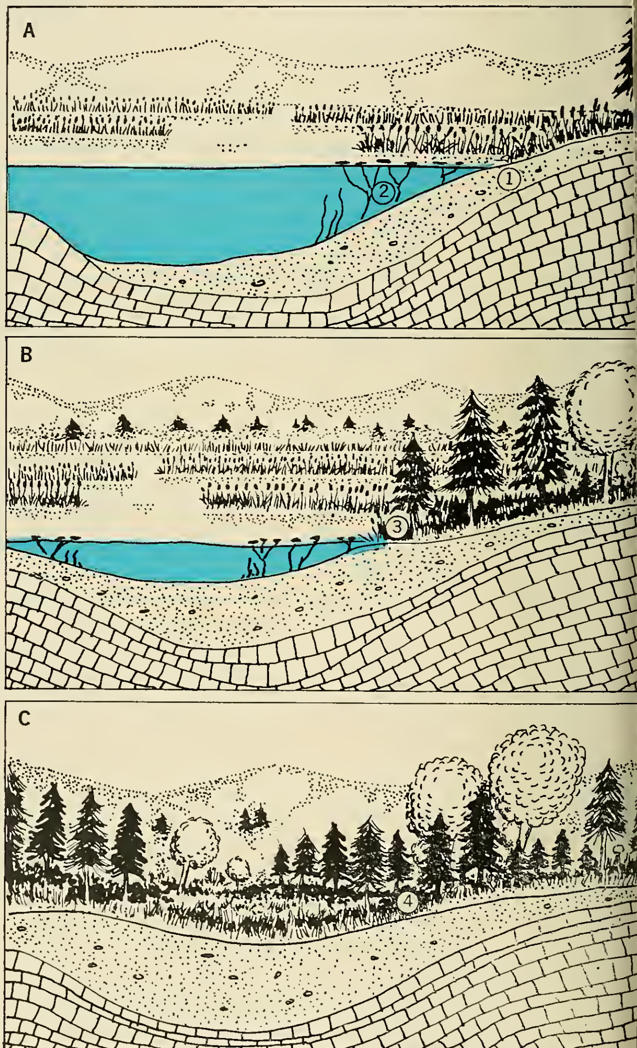
The appearance of these symptoms follows a definite sequence. First, the algae population skyrockets in a man-fertilized lake. Water fleas (miniature freshwater shrimp), the staple in the diet of fry and minnows, cannot eat enough algae to keep these plants in check. As a result, billions of algae live their languid lives, reproduce, and then die. As they drift toward the bottom, their decomposing bodies exhaust the deepwater oxygen supply. Trout, whitefish, and other fish species suffocate in the oxygen-thin depths.

The lake's ecology, initially upset by excess nutrients, then becomes totally upended, since bacteria can

by Arthur D. Hasler and Bruce Ingersoll

convert only some of the dead algae into plant and animal food. Therefore, generation after generation of algae settle on the bottom, adding layer after layer to the muck. The rate of sedimentation is most rapid in a northern lake where bacter grow only during the summer whi nutrients are added throughout th year. As erosion and sedimentatio fill in the lake, shoreline vegetatio impinges on the open water. In tim

STAGES OF NATURAL LAKE SUCCESSION



Figures (A-C) portray the natural aging and disappearance of a lake in the Northern Hemisphere. A newly formed lake contains few algae or eroded materials. Later, shoreline runoff brings eroded soil (1) and plant nutrients into the lake; aquatic vegetation (2) (including algae) flourish and die, adding to debris on lake bottom; marsh plants and water-tolerant conifers (3) grow at lakeside. Eventually, the entire lake is filled and covered with forest vegetation (4).

ıe lake becomes so shallow and vergrown that it becomes a marsh r bog. The accelerated process of ging has taken its toll: the lake's fe is ended.

Cultural eutrophication is not new, or is it solely an American problem. ecent core samples of an Italian ke indicate that ancient Roman ɔad builders caused eutrophication y exposing nearby nutrient-rich mestone strata to erosion.

By the latter part of the nineteenth entury, a few scientists in Europe ıd the United States, alarmed about ıltural eutrophication, issued warngs that went unheeded. In 1896, on witzerland's Lake Zürich, the probm finally received notice, and durg the 1920's and 30's worldwide ientific interest began to focus on e problem. But research without ıplementation is impotent, and by e 1940's eutrophication was no nger confined primarily to farm ·lts and urban areas. It had folwed urban man in his quest for creation into the wilds.

It took the visual (and olfactory) ıpact of a huge body of water, Lake ·ie, suffocating as a sump for inıstrial waste, sewage, and urban ıd rural runoff to bring the probm of water pollution dramatically the public eye. Some now proɔunce Lake Erie "dead." We, hower, extend hope for recovery. For communities and industries in ıke Erie's drainage basin cease polting and fertilizing its waters, and a cleansing flow from Lake Huron permitted to reach and "flush out" e lake via the Detroit River, Erie ight show signs of recovery within decade. True, our hope is continnt upon many "ifs." However, it nnot be too strongly emphasized at these situations are reversible—at bodies of water will respond ıen the right steps are taken.

There is reason to fear for the her Great Lakes, together the eatest reservoir of clean fresh ıter in the world. Although Lake perior and Lake Huron bear only few signs of eutrophication so far, ırming amounts of DDT and other rsistent toxic pesticides have been tected in the highly prized flesh of ke trout caught in their waters.

Lake Michigan is also deteriorat- g rapidly from increasing effluents d may soon go the way of Erie. e stench of algae and weeds de- ying on beaches, compounded by

the wave-borne plague of dead alewives, makes eutrophication impossible to ignore in this once pure lake. Such cities as Muskegon, Gary, Chicago, Milwaukee, and Green Bay realize that the fate of Lake Michigan—to which they once owed their existence—is now uncertain.

Stewart L. Udall said a year ago that there is still time to save Lake Michigan, but warned that further delay in action would prove fatal. His statement is admittedly, and of necessity, vague, but it is correct.

The long-range outlook here is not encouraging because the mitten-shaped lake isn't in the mainstream of Great Lakes water circulation, and thus receives very little cleansing flow. Its tributaries carry heavy nutrient loads to its shallows, and consequently, along Michigan's southern rim scientists have found 44 times more phosphorus (in the form of sewage effluent and industrial waste) than the lake can handle.

Lake Michigan's fate would have been decided long ago had Chicago's engineers and city fathers lacked the foresight and imagination to reverse the lakeward flow of the Chicago River and channel it into the Illinois River, a tributary of the Mississippi. The metropolis now draws water from the lake, and discharges sewage effluent into the altered river system. As is sometimes the case in such diversion operations, they have alleviated their own problem but have contributed to the water problems o St. Louis and other cities locate farther down the Mississippi.

While concern for the future o the Great Lakes intensifies, distre is being voiced over eutrophicatio on many smaller bodies of wate Fishermen complain that dense ma of algae and rooted weeds make trol ing for pike impossible, and that th few fish they do manage to catch ar too tainted to eat. A summer cottage realizes that he will be landlocked his bay becomes any shallower, an a concerned parent forbids he youngsters to wade in the gree slurry of algae.

To stop cultural eutrophication the sources of nutrients for alga growth and reproduction must b pinpointed. A 1967 survey, represen ative of the Midwest, indicates tha 6 per cent of the nitrogen and 2 pe cent of the phosphorus reaching Wis consin waters come from septic tan seepage. Twenty-five per cent of th nitrogen and 56 per cent of th phosphorus come from municipa sewage treatment plants. Runof from manured fields accounts for 1 and 22 per cent of these elements while urban runoff supplies 6 an 10 per cent. Groundwater and direc rainfall on Wisconsin bodies of wate contribute, respectively, 42 per cen and 9 per cent of the nitrogen, bu together less than 4 per cent of th phosphorus. Industrial wastes whic bypass municipal treatment are a

CONDITION OF TWELVE U.S. LAKES

LAKE	LOCATION	EXCEL-LENT	GOOD	FAIR	POOR	ENDAN-GERED	IMPROV-ING
Crater	Oregon	■				■	
Superior	Great Lakes	■				■	
Tahoe	Calif.—Nev.	■				■	
George	New York		■			■	
Cayuga	New York		■			■	
Washington	Washington			■			■
Okoboji	Iowa		■				■
Mendota	Wisconsin			■		■	
Erie	Great Lakes				■	■	
Douglas	Michigan		■			■	
Apopka	Florida				■		■
Okeechobee	Florida		■			■	

source of trace amounts of each of these chemical substances.

The nitrogen contribution of groundwater and rainfall will continue to be significant as long as automobile exhaust and industrial smokestacks keep spewing nitrogen into the atmosphere. Rain, in cleansing the air, picks up this nitrogen and deposits it directly into lakes and streams or indirectly in groundwater. Nitrogen-laden rain falling on land also percolates down to the subterranean water table, the level of groundwater.

It must be remembered that the natural rate of eutrophication is the base rate for cultural eutrophication. Moreover, the natural rate depends on whether the soil in a lake's drainage basin is rich or poor in nutrients. For this reason, thousands of lakes in a nutrient-poor belt stretching from northern Minnesota and Ontario to Maine and Quebec have changed very little since the last glacier retreated 10,000 years ago. Found in sandy or granitic terrain and unspoiled by man, these deep lakes have kept their gin-clear purity and their youth—they are oligotrophic. However, should we disturb their basins and fertilize their waters, they would immediately undergo cultural eutrophication.

Seepage from the septic tanks of just a few summer cabins and resorts, for example, is rich enough in nutrients to speed up the aging process. Cochran Lake, once a pure gem set in the northern Wisconsin wilds, has deteriorated so rapidly since the first of seven cottages was built on its shores ten years ago that it now looks like a 300-acre caldron of pea soup.

Lakes with large drainage basins in limestone terrain, which is usually high in phosphorus, are far more likely to show their age than lakes in granitic or sandy basins. Because of their high nutrient content, they become shallow and die under encroaching cattails, reeds, and marsh grasses. But even though such lakes are already highly fertilized through natural means, whenever man is present his actions become the determining factor in the rate at which lakes fill in. Unless septic tank seepage is stanched, Cochran Lake—and thousands of other lakes in the resort areas of northern United States, Canada, Scandinavia, and the Alps—will be ruined.

While faulty septic tanks are a

najor source of nutrients in rural regions, their over-all contribution loes not approach that of municipal sewage treatment plants. It has been estimated that 260 million pounds of phosphorus and 511 million pounds of nitrogen reach the nation's surface waters in the form of municipal sewage each year. Substantial amounts of these plant nutrients are discharged in effluent even after sewage is treated. As much as 75 per cent of the phosphorus in sewage comes from detergents. In addition o phosphorus and nitrogen, vitamins, amino acids, and growth hormones have been found in effluent—substances which contribute to the growth of algae and weeds. These growth stimulants are synthesized nadvertently in the biological processes of sewage treatment.

Since cities and villages across the country are rather impartial in lumping their sewage, rivers too are receiving their share of nutrients for eutrophication. This is most obvious wherever rivers have been dammed and currents slowed enough to give algae a chance to multiply. Because most of the nation's rivers have been systematically converted into series of impoundments since the 1930's, cultural eutrophication in these man-made lakes is now a common problem.

Algae blooms foul many of the man-made lakes in the TVA system, as well as the backwaters of hydroelectric dams on the Missouri and Snake rivers. The Mississippi—"father of waters"—carries partially treated sewage from Minneapolis and St. Paul forty miles downstream o Lake Pepin where algae thrive on sewage nutrients. As algae die and settle to the bottom with other sediments, the sluggish lake becomes shallower, increasing the possibility f spring flooding at Winona, Minn., nd other downriver towns.

Formidable as it is, cultural eutrophication isn't inevitable. For example, five years ago officials from 0-plus local government bodies became alarmed about algal slime at sewage outlets on Lake Tahoe on the California-Nevada border, touted as ne of the clearest lakes of North America. With the entire Tahoe Basin's livelihood—tourism and gambling—at stake, they banded together and consulted sanitary engineers and limnologists. The prescribed cure: sewage treatment nd diversion.

The South Tahoe Public Utility District, spurred by action committees of panicked businessmen, obtained a $10 million grant from Washington, raised another $9 million, and this year built a plant to treat sewage and a pipeline to carry effluent over a mountain pass to an irrigation reservoir. In diverting the effluent from the lake basin, the South Tahoe district provided California desert farms with nutrient-rich water. Meanwhile, the 42 voters of Round Hill, Nev., (most being gaming-house owners) floated a $5.8 million bond for their own sewage treatment-diversion project, fearing that smelly scum would hurt business at their lakeshore casinos and hotels. And if other Tahoe communities act right now, eutrophication should never smirch the lake's reputation for clarity—at least not for several thousands of years.

Diversion is currently the most effective measure we have to combat eutrophication, since it immediately deprives nuisance vegetation of nitrogen, phosphorus, and other nutrients. Moreover, until some technological breakthrough occurs in sewage treatment—now far from a completely effective process—diversion will continue to be the logical approach.

Sanitary engineers haven't yet found a process, chemical or biochemical, that offers an economical alternative to diverting effluent around lakes. Nevertheless, research is being pressed throughout the country. A pilot plant, for example, has been built to test a chemical process at Ely, Minn., the launching point for canoe trips into the Superior National Forest. Research teams have investigated the feasibility of using algae to remove nutrients from effluent. The plan is to grow algae in effluent-filled ponds until they have consumed all the nutrients. Then the algae would be harvested and the nutrient-poor effluent discharged directly into a lake, obviating the need for diversion. The researchers, in practice, have been stymied by several technical problems: for one, how can algae be put to use? Unfortunately, there is no demand for algae as a fertilizer or as an animal food.

While the logic of diverting effluent is obvious, particularly in light of the shortcomings of sewage treatment, it often hasn't been accepted. Opponents of diversion in Madison, Wis., for instance, argued that runoff from manured farmland—not municipal sewage—was the chief cause of eutrophication in Lake Monona, one of four lakes linked by the sluggish Yahara River. Nevertheless, soon after Madison began diverting all of its effluent around Lake Monona in 1936, the amount of copper sulfate needed to kill algae dropped from carloads to a few handfuls by 1956.

As Madison learned in the late 1930's, diversion requires a sense of responsibility and a regard for downstream communities. That city, in sparing Lake Monona, poured its effluent into Lake Waubesa and indirectly into Lake Kegonsa. This half-measure promptly fertilized their waters. Residents, enraged by the proliferating algae that threatened to ruin their lakes, sued the city. In 1941 legislators passed an antipollution bill aimed at Madison. Gov. Julius Heil, however, vetoed it on the ground that there was no consensus on the main cause of eutrophication. Although the bill was later enacted, it was not until 1959 that Madison's effluent was diverted completely from Waubesa and Kegonsa.

Foes of diverting sewage plant effluent around Seattle's Lake Washington to Puget Sound claimed that farm runoff was responsible for cultural eutrophication—just as had been claimed in Madison—even though the 24-mile long lake was absorbing the effluent of ten treatment plants by 1950. In this case, it took the lavender bloom of *Oscillatoria rubescens*, the same alga that discolored Lake Zürich, to awaken the public. Mass apathy dissolved, but a welter of conflicting opinions took its place and for a time threatened to defeat the attempts to divert sewage around Lake Washington. Eventually, 5,000 women, backed by the Municipal League and the League of Women Voters, went from door to door, mustering support for a bond issue to be used for diversion. Recently, voters reversed the stand they took in 1956 and approved the bond issue and a charter for a new metropolitan governmental body that would cope with the sewage problem. Although the diversion project hasn't been completed, the picturesque lake is nearly as clear as it was eighteen years ago. Its clarity should continue to improve as its effluent is

diverted to the tide-washed sound.

Diversion projects are sometimes condemned as costly boondoggles, since rainfall inevitably contributes so much nitrogen to lakes, whether or not diversion is practiced. Critics, however, fail to consider, or choose to ignore, the fact that municipal sewage—not rainfall—is the major source of phosphorous, the other stimulant of cultural eutrophication.

There is no standard remedy for ailing lakes. Diversion is no cure-all. It has disadvantages in addition to its expense and capacity for creating or aggravating water problems elsewhere. Diversion can negate itself, particularly in water-scarce regions where sources of clean water that might have flushed lakes clean have been channeled instead into diversion systems to carry away sewage effluent. Thus, the advantage of diverting effluent is sometimes offset by the disadvantage of diverting potentially cleansing inflows. Engineers, aware of this drawback, are exploring the possibility of using "infertile" water from the Columbia River to rinse Moses Lake in central Washington.

Harvesting weeds and fish to remove nutrients from fertilized lakes promises to supplement diversion projects very effectively. Seining crews, for example, hauled 40 pounds of carp per acre from Madison's Lake Mendota. Since the nitrogen and phosphorus content of fish flesh is 2.5 and 0.2 per cent, respectively, 500 pounds of carp harvested removed 12.5 pounds of nitrogen and a pound of phosphorus from the lakes. The 1966 carp catch yielded 16,000 pounds of nitrogen and 800 pounds of phosphorus. The nutrient "yield" of this method could be easily expanded in most eutrophic lakes with more intensive harvesting of carp and other rough fish.

A program to perfect weed-harvesting techniques and to evaluate their effectiveness was begun last summer on Lake Sallie, a densely populated lake in the vacation area of Detroit Lakes, Minn. By "cropping" one-third of the lake three times to a depth of five feet below the surface, the researchers expect to remove substantially more nutrients in one summer than enter the lake in a year. The outlook for harvesting algae on a large scale, however, isn't nearly as bright. No economical equipment has been de-

veloped to skim algae off lakes an impoundments.

While inventors are working o a variety of devices that "suck u algae like vacuum cleaners" o "strain algal scum from lakes," mem bers of the National Eutrophicatio Research Program are hunting fo a herbivore, perhaps some water fle or fish, with a huge appetite fo algae. The search may be extende abroad if no algae-craving counte parts can be found to the weed-eat ing snails used in the southeaster United States. Precautions. howeve must be taken to screen out "exotic species that could become nuisance Also, of two viruses known to caus diseases among blue-green algae, on is being tested, and more virulen species are being sought.

The best that can be said for spray ing chemical poisons on lakes in th grip of algae and weeds is that it i usually a futile undertaking. Trea ing a lake with copper sulfate o other toxic chemicals is no more e fective than taking aspirin for brain tumor. It offers only temporar relief. masking the symptoms of cu tural eutrophication. In the long ru it makes a lake sicker. Poisonin algae and weeds simply accelerate the natural process of growth, deat and decay, thereby freeing nutrient for another cycle of plant produ tion. This has been borne out b studies of blue-green algae in Or gon's Upper Klamath Lake, whic first showed signs of eutrophicatio eighty years ago. In the peak growt month of August. Klamath alga contain within their cells three time as much nitrogen as is dissolved i the lake. Killing an alga therefor would release this nitrogen for fu ther growth.

Chemical poisons should be use only as a last resort, for once dumpe into a body of water, they cannot b confined to one locality. They di solve and spread far beyond the are treated. Dispersed eventually b wave action throughout a lake, the adversely alter the fragile fabric o aquatic communities of many sp cies. Too little is known about th sublethal effects of such poisons t risk their use.

We can take several steps—a more effective than chemical poison ing—to bolster the two-pronged a tack of diverting effluent and remov ing nutrients. By separating sewe systems for storm runoff and sewag

ommunities can forestall the lake ertilization that occurs when nutri-nt-rich combined sewers overflow fter heavy rains. Damaging septic ınk seepage can be curbed by pass-ıg legislation that would require ıat tanks be installed at a "safe" dis-ınce from bodies of water. Wiscon-in legislators, for instance, recently ecided that lakes and rivers would e safe from fertilization only if eptic tanks are set back as far as ,000 feet and 300 feet, respectively. 'hey also set more stringent specifi-ations for septic tanks themselves. 'he specifications vary with the orosity of the soil.

Livestock growers could also fight ultural eutrophication by adopting ıe European practice of fluidizing nd storing manure in vats, from 'inter freeze-up until the spring ıaw, and then spraying it on their elds when the soil can better absorb :. The bulk of the manure now pread on frozen cropland runs off 'ith spring meltwater to fertilize ıkes and streams. This is significant onsidering the fact that the amount f manure, produced each year in ıe Midwest alone, is equivalent to uman sewage of a population of 350 ıillion. The chief drawback of the uropean method is its expense. ederal funds for water and soil onservation, however, could pos-bly be used to help farmers pay ›r costly storage tanks and spray-ıg equipment.

We still have much to learn about ıe complexities of the eutrophica-on process. There is an urgent need ›r more research on such factors as lake's depth, size, and configura-on, its drainage basin and sources f nutrients, and its aquatic com-ıunities. But such research is com-licated because biological and eco-›gical factors vary with every lake, ond, and reservoir. Systems analy-s with computers promises to be ıe research tool that will enable us supply precise data on the poten-alities of eutrophication.

Improved research, however, is nly part of the solution to this di-mma. Unfortunately there isn't me to raise an enlightened genera-on to cope with eutrophication. Al-ıough we don't have all the answers, e must heed the warnings given by ıe waterways around us that have ıllen into an advanced state of de-ıy. If we delay, the price may be o dear to pay.

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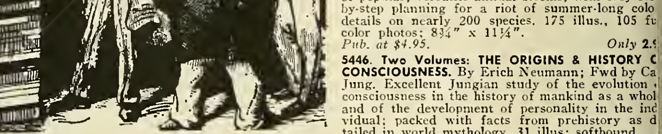

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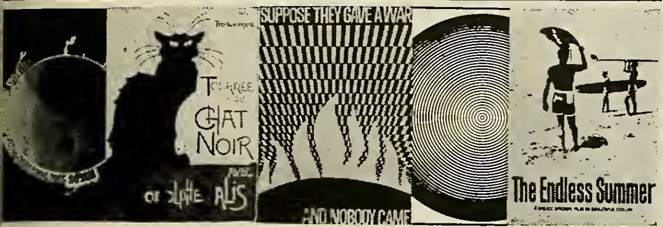

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Natural History in Cities

by Marston Bates

In the issue of this magazine for October, 1967, I aired some of my ideas about the teaching of biology, stressing the importance of the natural history approach in introductory courses. I have often been told that this is fine for country kids but that it is not adapted to the city environment. I have to admit that it is much easier to see a wide variety of plants and animals in the country. But I do not believe that this should be the governing consideration; on the contrary, the presumed lack of familiarity would make it even more important to give city people some understanding of the biosphere. How many children are there who have never seen a cow?

As a nation, we are becoming more and more urban. In 1910, according to the Bureau of the Census, 45.7 per cent of the population of the United States was urban; by 1960, the percentage in metropolitan areas had risen to 69.9, and the trend continues. City people thus form a majority of our population, and their votes will determine how we manage our portion of this spaceship earth. If we are to save any unmodified landscapes and maintain (or achieve) a healthy environment, we need the support of these city people. Most of them will be exposed to biology in high school, and this seems the logical place to arouse their interest in environmental planning, conservation of resources, pollution control, and the like.

As a matter of fact, there are plenty of opportunities to study natural history in cities—even though cities present a rather special aspect of the subject. In high school teaching, I think it would be useful to have a greenhouse, and visits to zoos, botanical gardens, and museums would be in order—important resources that are unavailable in a small town. But beyond this, an astonishing number of kinds of animals and plants have been able to adapt to the urban environment. Frank Lutz, for many years Curator of Insects at The American Museum of Natural History, in New York, published a book, in 1941, on the insects he had collected in his back yard—75 by 100 feet, and a block from the railway station in Ramsey, New Jersey. He found 1,402 species—and entitled his book *A Lot of Insects*.

A midtown apartment could not compete with Dr. Lutz's New Jersey back yard. But it might have cockroaches, silverfish, flies, and spiders; and in run-down neighborhoods, other animals could be added to the list. In many apartments, there is an aquarium with tropical fish, and a terrarium offers a way to keep lizards and frogs. One young friend of mine keeps a small boa constrictor in his room. Apartment house horticulturists can choose from a considerable number of different shade-tolerant plants. Then there are dogs and cats, as well as canaries, finches, parrots, and other pets. Thus even an urban apartment has natural history possibilities.

The city is the extreme form of the man-altered landscape, and its inhabitants include all five of the subdivisions of the human entourage that I discussed in this column last January: opportunists, cultigens, captives, inquilines, and parasites. One might argue that all of the plant and animal residents of metropolitan areas belong to this entourage that is dependent in some way on man. (There are many migrant birds—but they are not residents.) Even the inconspicuous organisms of the soil must be greatly affected by human action. Animals like opossums and raccoons, which rummage in suburban garbage, fit very nicely, I think, into the class that I called opportunists.

Of other groups, the cultigens include the ubiquitous dogs and cats—assuming for the moment that cats can be classified as "domesticated"- as well as plants like the fanc hybrid orchids that some people ai able to grow in the light from wi dows. Captives run the gamut of an mals that can be bought in pet shop and include quite a few wild plan like the increasingly popular cact Among the inquilines are rats, mic cockroaches, and a variety of othe animal life.

Bedbugs, common enough in man Old World cities (do we still allo them in the United States?), prese a nice problem in classification should they be called inquilines o parasites? They live directly off ma but they don't associate with him e cept for feeding. My memories o bedbugs include the wicker chairs i the lobby of the tourist hotel i Salonika. In prewar days, thes harbored a large population of bug that lived by nipping the arms o resting guests (or guides). I wonde whether the present Greek govern ment has been able to cope with thi problem. True parasites include lic and fleas. I don't know about th prevalence of lice in American cities but London, when slum children wer evacuated during the blitz, turned ou to be well supplied.

John Kieran, in his book on th *Natural History of New York City* reports that in one typical yea 276,119 dogs were licensed, and i the same year, the S.P.C.A. destroye 59,413 dogs, presumably mostl strays, and 133,436 cats. Kieran doe not think that this means that ther are more than twice as many cat as dogs in the city, because cats bree faster than dogs, and kittens ar more apt to be unwanted than pup pies. He estimates the actual ca population of the city to be abou 300,000.

Census statistics on animals i cities (other than man himself) ar hard to come by. Dr. David Davis who studied the rat population o

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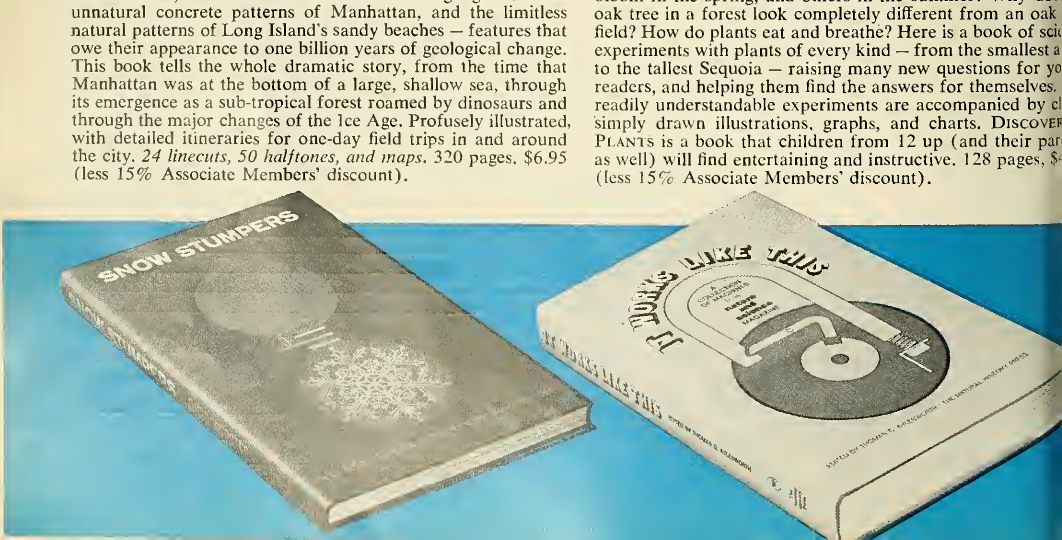

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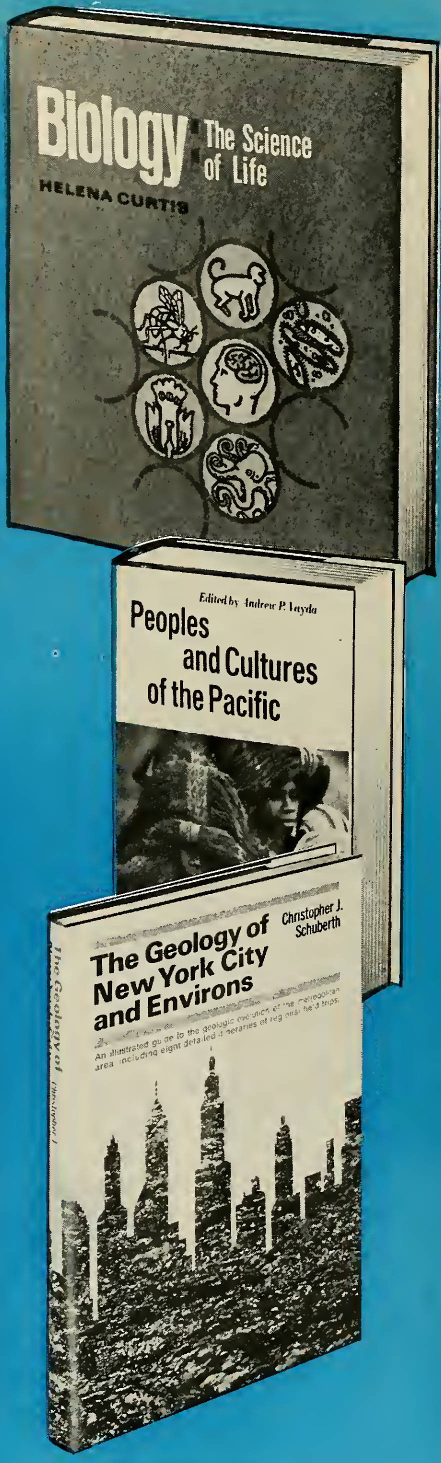


Baltimore for many years estimate that in 1944 the city harbore 400,000 rats (the human populatio at that time was 659,000). He be lieved that the rats declined in num bers to 165,000 in 1947, and 65,00 in 1949. Whether this downwar trend has continued I don't know Certainly rats are still commo enough in many parts of our cities as became rather obvious in New York with the strike of the garbag collectors. I was interested, in read ing the Kerner report on riots, to come across the estimate that ther were 14,000 cases of rat bite in th United States in 1965, mostly in th ghettos of our cities—another mar of the miserable living conditions.

Vermin are much less abundant in American cities now than they used to be. This is partly because of th widespread use of pesticides, but i also reflects the decline of the horse Livery stables provided a haven fo rats, flies, and other animals, whil the manure in the streets supported hordes of English sparrows. I don't know whether it would be possible to measure the noxious side effects of horses against those of automobiles—they are so very different. Horses produced flies and smells, while auto mobiles pollute the atmosphere—and automobiles multiply much faster.

Among opportunists, weeds have long fascinated me—plants that most people dislike, pull up, cut down, spray with herbicides. Yet they per sist and flourish in the man-altered landscape. They seem sturdy; they manage well in gardens and lawns and vacant lots, along railway tracks and in similar improbable places. But most of them would be very rare if man did not clear land for them. In many cases it seems likely that weeds are plant species that would have be come extinct if man had not come along in time to save them.

I find lawns puzzling. Why are people so dead set against crabgrass and dandelions? I don't see much difference between crabgrass and lawn grass—why not let the former take over? And dandelions add nice spots of color. I have a letter from a man in Philadelphia, Joseph P. Walker, saying that "Dr. Jack Mc-Cormick and I are presently work ing on the question of why people mow grass. . . . What are the origins of mowers and mowing? What, if any, psychological motivation is

there for mowing?" I couldn't help any with answers, but I put the letter in a "for attention" pile in the hope that sometime I might come up with an idea. I did find some comment in an offbeat book on gardening by Warren G. Kenfield, *The Wild Gardener in the Wild Landscape.* The author thinks that lawn mowers are simply the modern version of a cow tethered by the house. The lawn, he says, is "a living fossil in a modern human zoo." In a footnote he explains, "I really like lawns. They have the pure clean simplicity of a freshly painted floor, or a bolt of monocolored cloth. I like them as I like sheathing evening gowns on other men's women, beautiful to look at, but horribly expensive to support."

Weeds (and lawns and gardens) seem to me to offer all sorts of possible projects for botanically minded students in city or suburban high schools. What plants are able to manage in the cracks of less-used sidewalks? What is the ecology of a vacant lot, and what weeds appear around an abandoned building? R. S. R. Fitter, in an excellent book on *London's Natural History* (in the Collins "New Naturalist" series—I think the book has not been published in this country, but it ought to be in the library of every metropolitan high school) lists 126 species of flowering plants and ferns found in bombed sites in London after the Second World War—avoiding sites that included gardens or parts of gardens "unless the species present prior to bombing were known and could be excluded." I hope we won't have an opportunity to make comparable studies in this country, but there is plenty of chance for ecological observation of other kinds of destruction.

A surprising number of birds have taken to the urban and suburban environment, offering many possibilities for study. For the London area, Fitter lists 74 breeding species that are resident throughout the year, 26 breeding species that are found in summer only, 45 species that are winter visitors, and 41 species that pass through in the course of migration. John Kieran devotes quite a bit of space in his book to the discussion of birds in New York, but does not give any statistics. John Bull, in his *Birds of the New York Area*, gives notes on 412 species, but his "New York area" includes all of Long Island, southern counties of New York State, and northern counties of New Jersey, thus including country that is far from strictly "urban" though easy enough of access from the city.

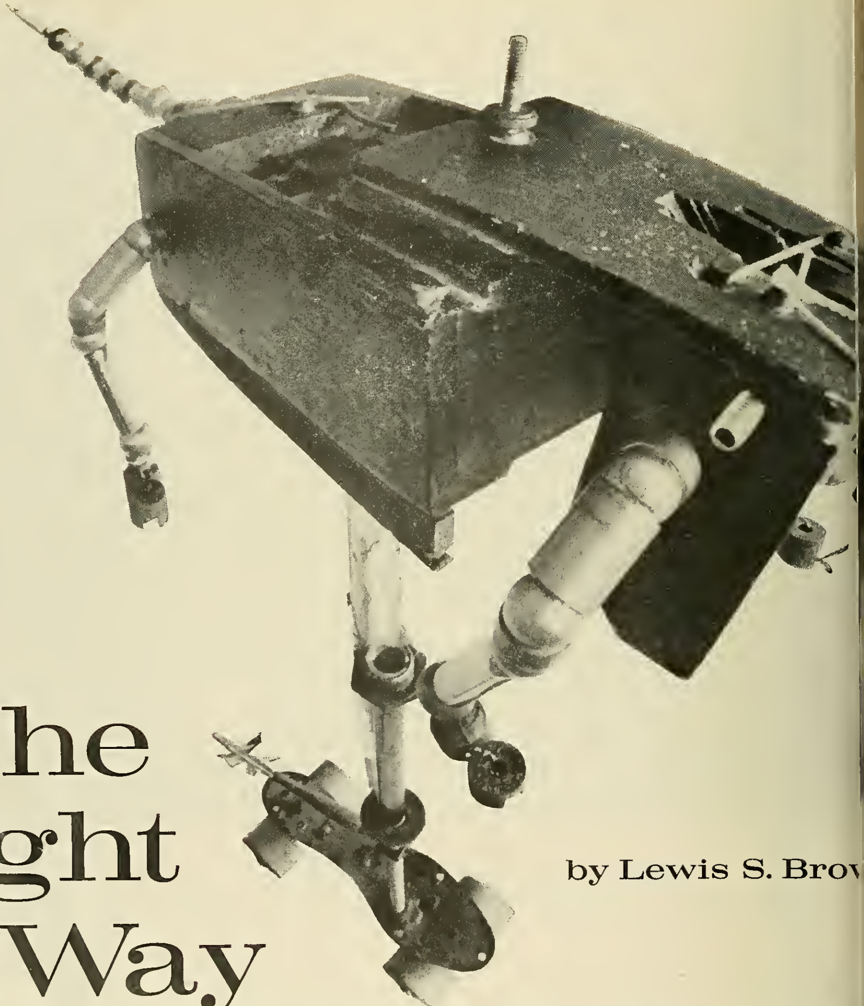
I should think someone would have published an account of bird life in Central Park, but I have not come across any such. John Bull remarks that the park is "one of the best places for migrant passerines and noteworthy for its warblers; the best portion is the 'Ramble' between 72nd and 81st streets." Of the "Ramble," John Kieran remarks that "as many as twenty-nine species of warbler have been observed on a single day in May."

Someone should write a book about city birds around the world. It would make a nice ecological "project" and a good excuse for travel. Do pigeons occur in all cities? I asked my ornithological friend Robert Storer; he said he couldn't remember seeing them in Madagascar, but he wasn't sure. He was struck there by the absence of English sparrows, now so common almost everywhere in the world.

In Honolulu the common street birds are mynas, Chinese doves, and English sparrows, getting along together very nicely. The mynas have a curious habit of "holding court"—two birds fighting, surrounded by a ring of watchers seemingly intent on the outcome. The spectacle is said to stop traffic sometimes. For a while I saw no pigeons there, but then I found a large flock that roosted under the eaves of the Bishop Museum, apparently going out to forage in the countryside during the day.

Last summer in San Juan, Puerto Rico, the hotel where I stayed served breakfast on an outdoor terrace, and the charming little Puerto Rican honey creepers invaded the tables to get tidbits from the guests. At night the grounds resounded with the bird-like calls of the coqui, a particularly vocal tree frog. A musician told me it was rumored that the governor sent out to collect coquis that could span a full octave (most coquis don't quite make it) for release in the Fortaleza where he lives and entertains distinguished visitors.

Cities, undeniably, are quite different from rain forest or north woods, but this does not mean that they are devoid of natural history.



The Right Way to Walk Fou

by Lewis S. Brov

People believe, in a general way at least, that they know how animals walk. But they are usually wrong. Everyone, including those who are aware that man, too, is an animal, takes walking too much for granted. When the locomotion is bipedal walking, which man learns early in life, it draws little attention unless it is grotesque or piquant. When it is quadrupedal walking, people are even less inclined to analyze it. It is too long since their infancy, when they were crawlers moving around on all fours basically like a puppy, a kitten—or a baby giraffe.

After three decades of studying the ways in which quadrupeds use their feet for traveling, and of discussing animal gaits with anyone willing to talk and listen, I am no longer surprised at the misconcep tions about animal motion. Wh does astonish me, after contact wit people from widely different bacl grounds—farmers, laborers, scho ars, horsemen, artists, scientists is that they uniformly believe th same things that are not so, eve about that common animal, the hors

In other words, most people d not recognize what I call the "tru

To study the gaits of the
quadrupeds, the author built this bizarre mechanical beast and mounted it on a roller skate. Propelled by a screw drive, it places each foot in turn, thus simulating one phase of a chosen stride. The articulated body and legs are adjustable, as are the head and tail. And the beast's name? Carneirotherium.

Legged

ılk." Instead, they are content with e "false walk" depicted in so any paintings, and in sculptured ırses (most of which would topple er if they tried to walk). There are so what can be called the "think- 's walks," which are not so much lse as imagined, although it has en found that an animal will occa- ınally use them.

Such mistakes about four-legged gaits ordinarily go unnoticed. To be sure, horsemen watch keenly the leg movements of a single species so they do agree, and correctly, on some aspects of the walking gait. Experts of other kinds, however, except for a few scientists willing to spend many years on unglamorous research, have contributed little to our knowledge of walking or other quadrupedal motion. The general feeling is that such movement is too complicated, variable, and unpredictable. This is at least two-thirds fallacy. Complicated or not, quadrupedal locomotion is surprisingly uniform and predictable. Still, artists and others dealing with such complicated movements err more often than not. The work of art that is scientifically accurate as well as charming is a rarity.

A delightful example concerns a sculptor, name unknown, who produced a walking horse in bronze. This was no massive work; it stood only sixteen inches high, but it received almost universal acclaim as a wonderful specimen from ancient Greece. Many scholarly treatises attested to its beauty and perfection; in New York, the Metropolitan Museum of Art bought it and proudly kept it on permanent display. And then, in 1967, this horse fell into disgrace. One of the museum's staff had accidently noticed something suspicious, had investigated and then announced that this masterpiece was in the neighborhood of 2,400 years too young—it was a modern forgery, and *Time* magazine gave it an appropriate name: "Phony Pony." In August, 1968, two art experts came to the defense of its authenticity and an interesting argument began. However, in all the discussion about the specimen's genuineness I noted hardly anything —either in praise or condemnation— about its quadrupedal action, even though the unknown sculptor had cast his phony pony in a phase of motion that depicted, with near perfection, a position that can occur only in the true walk. Even the imposed restraint on the animal, indicated by the open mouth and the angle of neck to head, is surprisingly natural. What fascinates me, therefore, is that with so strong a tradition in equestrian art of false walking—from days of ancient Greece to the present—the alleged forger had produced so authentic a mode of walking—in ancient Greece the odds against it would have been very great.

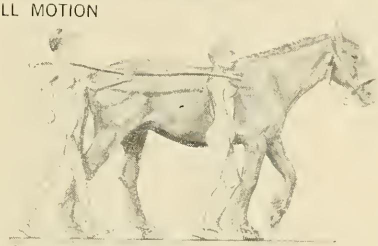
From where do we get this tradition of false walking? First, from living animals themselves—history's oldest source of information on animal motion. Animals have always been of interest to men and available for study. Unfortunately, merely observing a moving animal is not enough. Even in the walk, an animal's legs generally move too fast to be recorded accurately by any mind not already stocked with considerable knowledge of animal motion. Moreover, the motion is often obscured by an animal's fur or surroundings, and the legs are seldom positioned so the viewer can clearly see all four for a long enough period of time.

Information also comes from cave walls, Egyptian tombs, and Greek temples. However, their depictions were based on observation or, as centuries went by, on tradition and a slowly growing literature, so it is not surprising that these paintings and sculptures exhibit more opinion, imagination, and error than fact. I would guess that, beginning thousands of years ago and continuing into the present, well over half of the depictions intended to represent animals walking are incorrect.

Thirdly, our knowledge comes from written accounts. The earliest of these, like the earliest art works, were based on limited observations of actual animals or reports of such observations. Like the depictions, such writing is full of guesswork: very little is true. Moreover, animal motion—even the walk of a biped— is too complicated to describe accurately with words alone. And, as for even the best present-day writing on quadrupedal motion, the reader must begin by knowing almost as

MOTION BEGINS AT REAR

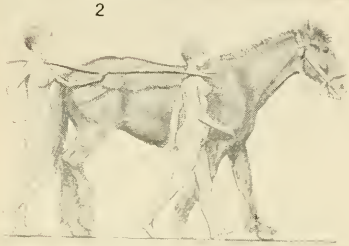
FULL MOTION



1 REGULAR STRIDE BEGINS

2

Principles of correct quadrupe
walking are demonstrated by a hors
and his biped companions, each of whor
represents one-half of a horse
As motion begins, the girl in back pushe
against the pole, thereby moving forwar
her own weight and the weight of the gir
in front of her. With this transfer of weight
the girl in back can begin to step, and
when she has completed approximately hal
of her first step, the girl in fron
begins to step in response to the pus
from behind, achieving full motion
Because the rear girl started
with a left foot, the other girl also
must start with the left foot
As with the girls, so with the horse
It starts with the left hind foot,
and throughout the eight phases of the stride,
the hind feet continue making their moves
at a uniform speed,
approximately a half-step ahead of the
corresponding front feet.



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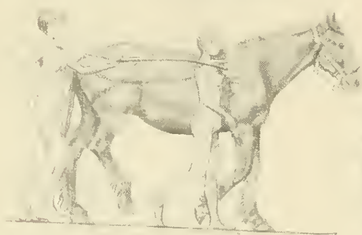

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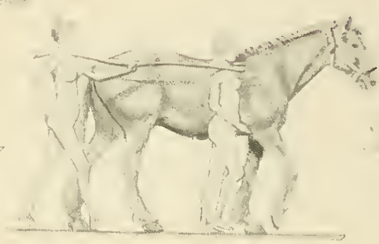

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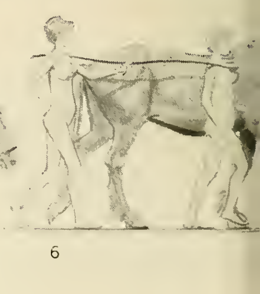


6

ch as the writer, unless he is pro- ed with adequate illustrations.

Why should a description of lking be so complicated? For one ng, any gait is composed of four tors: the foot sequence, the foot pport, the velocity, and the rhythm oduced by the feet striking the ound. These are often described clearly, and it is easy to imagine increase in confusion if a writer es to explain all four character- cs in relation to one another.

Also, it is the fashion among sci- ific writers on animal motion to phasize deviation in animal gaits her than similarity. Recently a emost expert proposed no fewer n 21 varieties of the walking gait ne. Another scientist has postu- ed as many as 108 different gaits t a quadruped can perform. In dition, writers have attributed ecial, peculiar walks to giraffes, ossums, young puppies, and kit- s. Actually, even a sloth obeys the e walk rule although it moves side down.

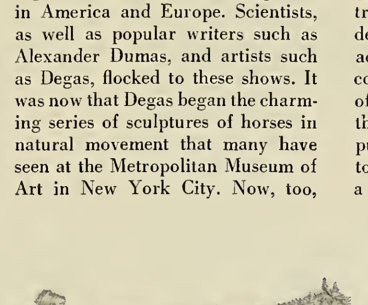
Today, one splendid tool for dying animal motion and dis- minating the facts does exist. This the camera, free from prejudice, inion, imagination, or error. Only h the camera can man attain the quired pictorial accuracy, and nsequently some hope for verbal curacy. Ironically, present-day icles and books on motion seldom ve enough carefully produced d selected photos to make their rds unequivocal. For such a oice marriage between word and ture, one must go back almost a ndred years.

In the late 1870's, an Englishman calling himself Eadweard Muybridge (he was more prosaically christened Edward James Muggeridge) succeeded in producing the first revealing photographs of animals in natural and successive motion. Technically, they were not what we call motion pictures today. The exposures were made, not on a whirling reel of film in a camera that "followed" the subject, but with a battery of still cameras, as many as 48 of them, lined up and timed so that each would show a phase of the action in split-second succession.

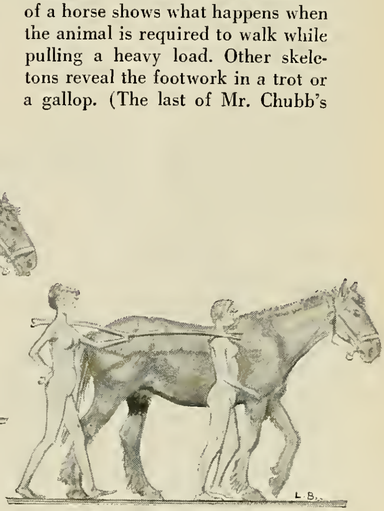
Though encumbered by the old-fashioned glass plates in his cameras, Muybridge was able to achieve, by ingenious means, pictures with exposures as brief as 1/6000 of a second while an animal moved down a track in front of the row of cameras. Then by arranging the pictures in the proper order, it was possible for the first time to see what actually occurs when a horse or other animal walks, trots, or gallops. Soon afterward, Muybridge devised a method of projecting these photographs in a way that made the animals seem to move before the eyes of an audience. Thus was produced the first photographic motion picture, and Muybridge began lecturing and showing his animated photos in America and Europe. Scientists, as well as popular writers such as Alexander Dumas, and artists such as Degas, flocked to these shows. It was now that Degas began the charming series of sculptures of horses in natural movement that many have seen at the Metropolitan Museum of Art in New York City. Now, too, Frederic Remington's portrayals of America's Wild West, so familiar to us all, began to include animals walking, trotting, and running with remarkably scientific accuracy. Museums of natural history, too, started paying some attention to the accurate portrayal of motion. The outstanding examples of this changed attitude are to be found at The American Museum of Natural History in New York.

In 1897, Samuel Harmsted Chubb, the son of a Maryland physician and himself a self-trained osteologist, came to New York, introduced himself to Henry Fairfield Osborn, then head of The American Museum, and showed him a new kind of osteological mount—one that displayed the bones of an animal in such a way as to show accurately the dynamics of the living animal. The result was that Mr. Chubb soon went to work on what was to become a small hall of "living skeletons." Before he died in 1949, it had become the most significant display of true animal motion anywhere in the world. As far as one person could combine fine craftsmanship, unceasing labor, and a high degree of intelligence, his work exemplifies perfection.

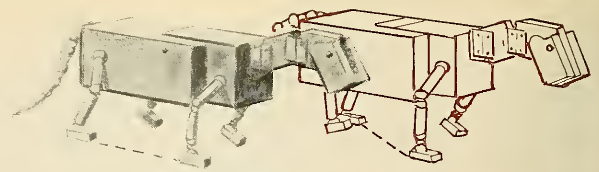
Most of his skeletons show a phase of movement taken from a regular gait. The quadrupedal walk is illustrated by four walking zebras, each depicting a significant phase of the action, and all four providing one complete cycle—a stride. A skeleton of a horse shows what happens when the animal is required to walk while pulling a heavy load. Other skeletons reveal the footwork in a trot or a gallop. (The last of Mr. Chubb's



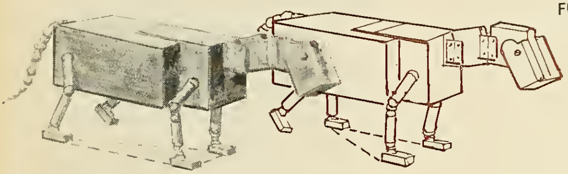
8 FIRST STRIDE ENDS



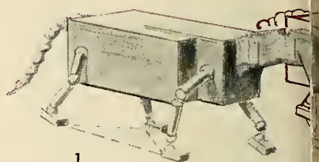
NEXT STRIDE BEGINS



FULL MOTION



MOTION BEGINS AT REAR



1

REGULAR STRIDE BEGINS

depictions was of a donkey bending laterally to permit a hind foot to scratch its jaw.)

Into the preparation of each skeleton went more hours of work and study than anyone unacquainted with this man would believe. Every angle of every bone was decided upon only after endless observation of living animals, followed by the taking and studying of many photographs. Mr. Chubb took both still and moving pictures, but was apparently too early to profit from use of slow-motion photography, which today is almost mandatory for serious research.

Most of the facts I have learned about quadrupedal walking, I have learned from either Muybridge or Chubb. All of these facts now have wide acceptance in the literature about gaits; and I have been able to substantiate all of them by my own studies. In more recent years my belief has grown that the gaits of animals, particularly the walk, developed in conformity with the demands of an almost Procrustean discipline. It is not the variation that surprises me; it is the basic conformity in all quadrupedal walking.

Of course, no one person can claim to have studied more than a few living, four-footed animals carefully. And since few imprints of prehistoric feet have been discovered, only conjecture is possible about animals long extinct. However, it is surely significant that the animals we do know have settled on the one walking stride—slow-motion pictures show that a horse, an elephant, a cat, a camel, a giraffe, a lizard, an amphibian, all walk with the same sequence of footfalls. Even the human infant while it is still creeping, or the baby monkey, conforms to this sequence.

It is not reasonable to suppose that this uniformity is accidental. What most people do not realize is that at some time or other in their evolution animals have had a number of choices of working patterns. Sir James Gray's count, in his treatise *Mechanics of the Tetrapod Skeleton*, shows that animals can theoretically advance their four feet in six different sequences. These I shall list in the following order:

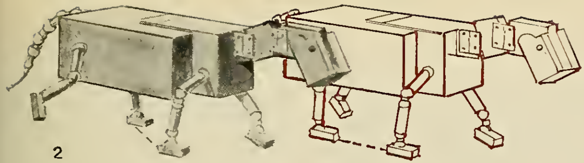
1. RH (right hind)
   RF (right front)
   LH (left hind)
   LF (left front)
2. RH, LF, LH, RF
3. RH, LH, RF, LF
4. RH, LH, LF, RF
5. RH, RF, LF, LH
6. RH. LF. RF. LH

Sequence 1 (in which the front foot begins advancing only after the hind foot on the same side has done so) is the only sequence ever used by quadrupeds when they walk normally—it is the one that evolution has favored.

Is there any functional and mechanical basis why this sequence should have become universal? To me, the answer is a decided yes. The feet and legs, as they move, form a series of dynamic tripods to support the animal's weight. In none of the other five sequences, whether possible or merely theoretical, are the tripods of support as good. In each of these other five, an increase of the animal's speed would bring problen of balance or the risk of one fo interfering with another.

Speed, of course, is relative. W distinguish, for example, b tween walking and running. But some point in evolution, walking w undoubtedly the means of achievin optimum velocity. When animal li first became terrestrial and creatur began to travel on land, their le must have been ill suited to spee if they were large creatures. So an mode of travel that kept the bod supported off the ground, while fu nishing a continuous forward mov ment, was adaptively significant. is likely that, early on, only one fo at a time could be moved, while th other three held the animal uprigh However, as A. Brazier Howell poin out, more and more speed was r quired as evolution progressed. Th allows us to conclude that if on single way to walk was safest an fastest, and best suited to all anima —whether their bodies were long c short, heavy or light, had long le or short ones—this was the gait th had the best chance of being adopte universally. The quadrupedal wal of today—the true walk—is just suc a gait.

Here we must be careful abo definitions. What is this walk? B cause bipedal and quadrupedal wal ing have common characteristics, is best to compare them. Webster definition of bipedal walking stresse several important points: that th pace (speed) is moderate; th movement is achieved by a series c foosteps; and that, by definitio these steps cannot be hops or leaps-



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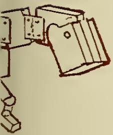
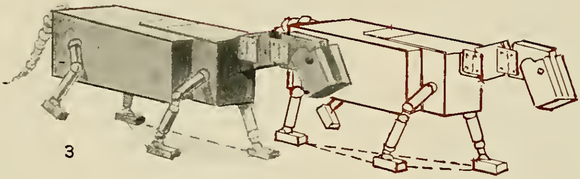
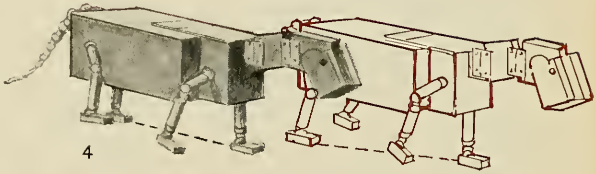




3

'RUE WALK is performed by the
;arneirotherium, shown in black. As motion
egins and the first foot is raised, the
ther three form a triangle on the ground.
'he left hind foot moved first, so the beast
nust next move the left front. As full motion
egins, he is supported by only his right feet—
ossible only while his momentum continues.
s stride begins (1) the left hind foot is back on
he ground, restoring triangular support.
'hase 2: right hind foot leaves the ground
nd support is diagonal (left hind, right front),
ut in a moment the left forefoot contributes
another big triangle (3). Next phase (4),
e right forefoot lifts and support is only by
e left feet, but immediate striking of the right
ind foot (5) restores triangular support. In (6)
iagonal feet (right hind, left front) again support
nly momentarily, followed by another good
iangle (7). The triangles indicate good
ipods (feet and legs) for supporting the
nimal's weight and maintaining its
quilibrium, since the center of gravity
lways lies within the triangle.



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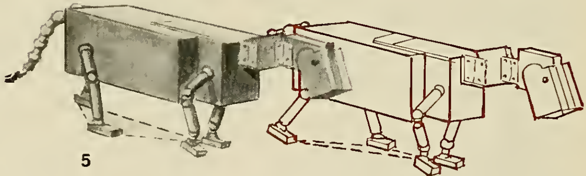

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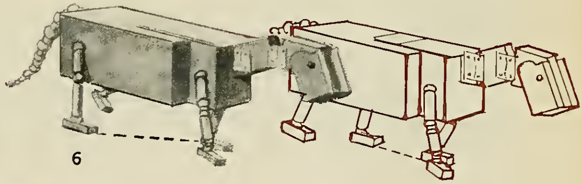
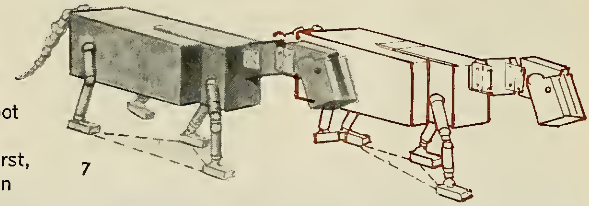


6

ALSE WALK (in color) becomes importantly
ifferent from the true walk when both gaits
re viewed at an angle and from above. The
ifferences show in the foot sequences and foot
upport. Foot support here is poor because of
equence. In the contrasting true walk, the first,
aised hind foot is followed by the front foot on
e same side; but in false walk, the hind
oot is followed by the front foot on the
pposite side. Result is a triangle that
small, away from the center of gravity,
iving almost no support for the left
ide of the moving animal. Later in the
tride, the right side of the animal
left similarly unsupported.



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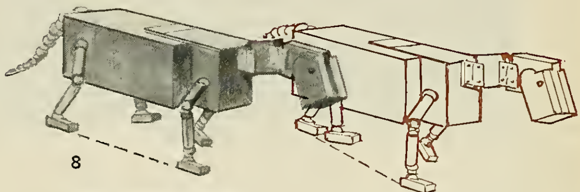


8

FIRST STRIDE ENDS

a biped always has one foot, at least, on the ground.

The description of the quadrupedal walk is less definite. The dictionary says that two of the quadruped's four feet are always on the ground. But does this mean two front feet or two hind feet: two side feet or one hind and one front foot? Actually, it means one of each pair of feet, front and back. Thus we have what amounts to two bipeds, one walking behind the other, each having at least one foot in contact with the ground. And the dictionary definition can now be amended to read: *quadrupedal walk*—to go by steps at a moderate speed, without hopping or running, with a gait in which, at any one time, at least one front foot and one hind foot are in contact with the ground.

A few terms used by writers to explain motion also need to be defined.

A *phase* is an instant of motion. A stride can comprise an optional number of phases.

A *step* is the complete movement of one foot.

A *stride* (cycle) is the amount of movement completed when each of the four feet has moved from its relative position at the beginning of the stride, has performed its function in advancing the animal, and is again in its original relative position.

A *gait* is progression composed of a series of successive strides that are more or less identical.

As for the gait, it can be symmetrical or asymmetrical. The walk is one of several symmetrical gaits. Symmetrical here means that at a given speed the animal will move the legs and feet on the left side of the body in exactly the same way that it moves the legs and feet on the right side. (Consequently, if a stride in this gait is divided into two equal parts, the second half of the stride is a mirror image of the first half of the stride.)

I have mentioned that four factors, present in any gait, must be remembered in any attempt to describe it. For the quadrupedal walk they are:

1. The foot *support*. This alternates during motion: three feet, two feet, three feet, two feet on the ground. If the walk is very slow, more support is needed—a succession of four feet, three feet, four feet, three feet, etc.

2. The footfall *sequence*. This is the order in which the feet are lifted and advanced. In the walk the pattern is a hind foot followed by the front foot on the same side, then the other hind foot, and other front foot. The sequence can start with any foot.

3. The *rhythm* (beat). Striking the ground, one foot follows another to give an uninterrupted beat of 1-2-3-4-1-2-3-4. There can be exceptions. For instance, an animal grazing across a field is performing an especially slow walk that does have interruptions.

4. The *velocity*. For any walk, of course, this is relatively slow.

Each factor contributes something important to the true walk, but it is confusing to think about all four simultaneously. Let us start with two of them: velocity and rhythm.

The panel of drawings on pages 34-35 shows how a standing quadruped begins to move, gains momentum, then continues along. For this sequence I have chosen a familiar demonstration animal, a horse The drawings show him with two friends; the view is from the right

The bipeds happen to be more than just girls. They also represent a four-legged animal. The pole connecting them serves as a quadrupedal backbone, and each girl corresponds to one-half of the horse Linking two bipeds in such fashion one moving behind the other, is an old device that neatly explains what happens when a standing quadruped moves into a regular stride. The drawings portray a complete stride in eight phases.

The rhythm is quite simple—the continuing pattern of left hind, left front, right hind, right front gives an almost even 1-2-3-4-1-2-3-4 cadence And, of course, there is always symmetry—the left side and right side take turns moving forward in exactly the same way.

What about the other two factors, the foot support sequence and the footfall sequence? These two contribute most to the equilibrium an animal must have. Without proper sequences of foot movement and support most animals would end up prone.

Sir James Gray has demonstrated this matter of quadrupedal equilibrium in his book *How Animals Move*. The animal is compared to a table, and this makes sense. When standing at rest, with the weight of its body centered between its four supporting legs, a quadruped corresponds to a four-legged table with a weight centered on its top. Now remove any one of the table's legs and it begins to topple over in the direction of that missing leg. With only three func-

oning legs, the table has "lost its ılance."

But there are ways to keep the ble upright. Starting with a four-gged table again, suppose we move ıe of its legs to a new position. The nter of gravity will now be located ithin the support of three legs, and hen the fourth leg is removed, the ble will not lose equilibrium. Or, stead, suppose we shift the weight ı the four-legged table to a new ısition centered over three legs. ow we can remove the fourth leg ıd the table will not topple. When ıy quadruped walks, it uses all of ese devices: It shifts its weight, it ıanges the position of its feet, and ı addition, it gains momentum. It in no danger of falling over. In ıort, it is fulfilling the requirements walking.

The usual quadruped for demon-rating this is the horse, but the rawings on pages 36-37 show an un-ımmon substitute—one that I built help me study the six different ays, according to theory, that an ıimal could walk. I named this creature Carneirotherium in humorous tribute to a friend of mine, the ethnologist Robert Carneiro.

This quadruped is a sort of proto-mammal—one of those beasts of long ago, part reptile, part mammal—and various parts of its body can move, allowing the body to assume positions in various planes. To demonstrate a gait, the creature is propelled by a screw drive and places each foot in turn to simulate one phase of a chosen stride. The body length is adjustable, as are the lengths of the legs, to simulate different animals; length of step and rate of movement can be controlled accurately.

In the panel, two Carneirotheriums are shown performing non-identical strides. The black one does the true walk; the other does the false walk. This juxtaposition allows us to compare how the legs and feet form patterns of support for the animal's weight as the beast moves forward.

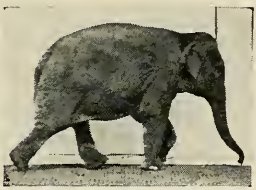
The true walk shows Carneirotherium going through the same movements we saw performed by the horse and two girls. Again the quadrupedal stride is shown in eight phases, and everything else is the same, except that the stride is now seen from above and a little in front. This viewpoint makes it easier to understand the way in which the feet support an animal as it walks.

It is by applying to both of these four-legged animals the same principles applied to the four-legged table, discussed earlier, that we see why the false walk is inferior. The most important single point to remember is that only when a four-footed animal walks correctly do its feet form the best triangles—the bases of tripods—to properly support the animal. If the feet form triangles that are small and do not lie under its center of gravity, the animal is walking incorrectly.

Some of the incorrect positions that artists commonly have drawn, painted, and modeled are represented in Sequence 2 of the six theoretically possible ways in which an animal can walk. This sequence is: right hind, left front, left hind, right

Continued on page 84






Sequence of photos by Muybridge shows a horse doing the true walk. A comparison of the last three horse pictures with the animals pictured above will reveal the same gait is favored y the other species, even by an infant human and the upside-down sloth.

IN DEFENSE OF MAGIC

Magic in the sense of something "inciting wonder" is here to stay: or if it is not, man will be vastly diminished by its loss. One need not be standing silent upon a peak in Darien. There is magic in the crash of surf on an unknown shore. but there is also magic in a mud puddle. There is a powerful magic in a crash of thunder, even more powerful in a nuclear explosion: but there is a very special magic in a child's kite or in the call of a gull and all that it evokes. Mark that leaf blown before the wind: it is important. No matter how sophisticated or blasé we become, that moment. this experience is all the treasure we shall reap in our few moments of identity.

What can rival a twilit meadow rich with the essence of June and spangled with fireflies? Here is magic, indeed, and the joy of pursuing through grass just touched with early dew a light now here, now there, now gone. Or of collecting several in a bottle and taking them indoors for illumination: or of tying one lightly with a thread to one's clothing. as natives of some tropical countries are reported to do at fiesta time. As children, we used to call them lightning bugs: in English-speaking countries, wingless kinds that emit a steady light from the ground are called glowworms wherever they occur. In fact, fireflies are neither flies nor bugs nor worms. but soft-bodied beetles called Lampyridae, a name based on an old Greek word that also evolved into our word "lamp."

Some of our commonest Lampyridae, curiously. give no light at all: these are day-flying beetles, which are often found on tree trunks. looking very much like ordinary fireflies but lacking the whitish "lamps" in their tails. The common European glowworm is a wingless female that produces a steady light. while the male of the same species is winged and not luminescent. Most fireflies of eastern North America are winged and produce a flashing light in both sexes. The larvae (and even the eggs!) of many fireflies also glow. This seems strange when we consider that the lights of fireflies are used by the adults to find the opposite sex of their own species in the dark. What function does luminescence serve in the eggs and larvae? One might assume that the immature stages simply "can't help glowing," since the rudiments of the light organs are developing within them. But the larval and adult organs are of quite a different nature, and if the larval light-producing cells are carefully excised. the adult will still develop normal light organs.

Luminescence probably first arose as a dim and diffuse product of certain normal body processes. for many substances oxidized slowly in the dark produce a glow: and a dim luminescence occurs in many simple organisms (especially in the sea). Natural light is known to occur in certain bacteria, fungi. one-celled animals, sponges. jellyfish-like animals. corals. marine worms, clams. snails. squids. arthropods, and. of course. a variety of deep-sea fishes—but never among the reptiles. birds. or mammals. It is possible that the earliest organisms on earth lived in an atmosphere devoid of oxygen. When oxygen first appeared—from the effects of sunlight on water vapor or from photosynthesis by primitive plants—it may have been toxic to these organisms. Luminescence may have developed as a system of getting rid of oxygen by burning it off as a "cold light." Later on, when plants and animals evolved that took advantage of oxygen to run their own body machinery, luminescence was preserved in a wide variety of organisms simply as a hangover from these ancient times. At least such is the belief of William McElroy and Howard Seliger, of Johns Hopkins University. our current leading authorities in this field. Their theory is supported by the fact that in many simple organisms luminescence

by HOWA

E STORY OF FIREFLIES

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seems to serve no function, and in some cases, a single species exists in both luminous and non-luminous forms, both apparently successful.

Adult fireflies possess the most complex light organs known, and these organs are still far from fully understood. Despite the intensity of the light they produce, the amount of heat is negligible. Only in very recent years has man developed chemical light-producing systems that rival that of the firefly in efficiency.

Perhaps the most notable contribution to an understanding of the light of fireflies was made in 1885 by the French physiologist Raphael Dubois. Dubois removed one light organ of the beetle *Pyrophorus*, ground it up in water, and left it until the light went out of its own accord. He then removed another light organ and ground it in boiling water for a short time, so that its light, too, was extinguished. Then he performed a neat bit of magic: when the two extracts were placed together, the light reappeared. He deduced that two substances were required to produce light, one of which was inactivated by heat. He called these two substances luciferin and luciferase (after Lucifer, who, among other more devilish traits, was the bearer of light). Dubois also learned how to obtain luminous bacteria from the skins of dead fish and squids on the seashore. The bacteria could be transferred to culture plates where they produced large colonies that glowed with a blue-green light. At the 1900 International Exposition in Paris, he created a sensation by lighting a small room with flasks containing suspensions of luminous bacteria.

A good deal more has now been learned about the production of animal light, and luciferin and luciferase have been obtained in purified crystalline form. McElroy and his colleagues at Johns Hopkins have synthesized luciferin. We now know that something more is needed: adenosine triphosphate (ATP). ATP may be less familiar to most persons than DDT or the CIA, but it happens to be even more important to us, providing as it does the energy for muscle contraction in animal bodies, including our own. In the light organ of the firefly, ATP energizes, not muscles, but the luciferin-luciferase system, the energy appearing not as mechanical work but as light. It has recently been proposed that luciferin and luciferase be employed in automated laboratories sent to Mars or other planets. The idea is that a scoop would pick up soil from the surface and mix it with water, oxygen, luciferin, and luciferase. Then if a glow were televised back to earth, we would know that ATP, the fifth requirement for firefly-light production, occurs there. The presence of ATP would mean, in turn, the existence of some kind of animal life in that alien soil. Thoughts such as these emphasize the need for caution when labeling the study of fireflies (or anything else) "useless."

In the living insect, an additional element is needed to account for the working of the system: some sort of nervous control. It was discovered long ago that cutting off the firefly's head caused the flashing to cease, although in some cases the light organ glows dimly for a long time. Later it was found that by electrical stimulation of the severed nerve cord one can produce experimental flashing. It is believed that nervous control is centered in the brain (much like the control of chirping in the cricket); impulses then travel to the light organs via the nerve cord and via delicate nerves that closely parallel the minute tubes carrying air to the light cells. We still do not know exactly how the flashing is triggered. Some have claimed that the nerves control the supply of oxygen to the light cells, but recent work suggests that this supply may be constant, and that the series of chemical reactions resulting in a light flash may be initiated by the synaptic fluid of the nerve endings. These are profound matters that we understand only poorly. Indeed, we still have much to learn about how the chemical energy supplied by ATP is converted into

the mechanical energy of ordinary muscle contraction.

The light organs of fireflies are complex structures, and recent studies using the electron microscope show them to be even more complex than once supposed. Each is composed of three layers: an outer "window," simply a transparent portion of the body wall; the light organ proper; and an inner layer of opaque, whitish cells filled with granules of uric acid, the so-called reflector.

Actually, the light organs vary a good deal in different kinds of fireflies. We also know that the color of the light varies in different species, and that this is a real difference in light color and not the result of a tinting or filtering effect of the window. Generally speaking, the light is yellowish, but it may have a greenish, bluish, or orange hue.

In the genus *Pyrophorus* (not really a true firefly, but a click beetle) there are two greenish lights just behind the head and an orange light on the abdomen. I well remember my first acquaintance with *Pyrophorus*. We were camped out near the ruins of Xochicalco, in Morelos, Mexico, when a disturbance caused me to peer out into the darkness, only to find that we were surrounded by pairs of glowing green eyes. The ghosts of Toltec warriors a few yards away? No, it proved to be a host of *Pyrophorus* in the bushes only a foot or two away. The story is told that when Sir Robert Dudley and Sir James Cavendish first landed in Cuba, they saw great numbers of lights moving about in the woods. Supposing them to be Spaniards with torches, ready to advance upon them, the British withdrew to their ships and went on to settle Jamaica. In this manner *Pyrophorus* may be said to have changed the course of history.

The South American "railroad worm" is an elongate glowworm having eleven greenish lights down each side of the body and two red lights on the head. These lights are quite brilliant, and when the insect is moving along the ground it looks like nothing so much as a fully lighted railroad train. The North American railroad worm is larger but lacks the red lights on the head. Both these insects are quite rare.

Today we are aware that there are differences not only in the nature, shape, and position of the light organs and in the color of the light of fireflies but also (and most particularly) in the behavior patterns of the males and females during courtship and mating. The males of the European glowworm fly toward a light only if it is of the shape, color, and intensity of that of the female of that species. In our common North American species, the females often rest on the ground or vegetation, and flash only in response to the flashes of the males. In one of the best-studied forms, *Photinus pyralis*, the male flies near the ground in a strongly undulating pattern, approaching the bottom of one of these undulations every six seconds; as he does so he makes a half-second flash, simultaneously rising and describing a "J" of yellow-green light. If he passes within a few feet of a female, the latter responds with a half-second flash of her own, but only after an interval of about two seconds (with only slight variation). This interval is an all-important signal to the male; we know this because the male will respond to various flashes, including even that of a flashlight, but *only* when these occur about two seconds after his own flash. If the female flashes at the proper interval, he flies toward her and flashes again, whereupon the female again responds in two seconds. This may be repeated several times until the male reaches the female and mates with her. There is no evidence that sound or smell plays any role in firefly mating.

The larger fireflies of eastern North America belong mostly to the genus *Photuris*, a confusing group in which the males show much variation in flash pattern but hardly any differences in structure or body color. For many years this problem bothered H. S. Barber, beetle specialist of the United States National Museum (not to be confused with H. G. Barber, a specialist on true bugs who worked at the National Museum at the same time—the two were "beetle Barber" and "bug Barber" to their colleagues). The results of H. S. Barber's study were not published until a year after his death in 1950. He found that in the Potomac Valley he could detect a woodland species with a short greenish-white flash on a second; a streamside species wi a slightly slower, faintly orang flash; a species occurring in ald groves and poising almost motio less, its light beginning dimly ar growing steadily in brilliance befo stopping abruptly, only to reappe at a different point several secon later; and so forth. Eventuall Barber recognized eighteen species *Photuris*, mainly on the basis of th flashes of the males; ten of these h had to name as new, since they ha not previously been recognized.

Dr. James E. Lloyd, of the Un versity of Florida, has recently com pleted a study of flash communica tion in the genus *Photinus*, th common smaller fireflies of the east ern United States. (Did you know that the Pacific Coast states, despit their many attractions, have almos no fireflies?) Lloyd, too, found sever al "hidden" species, first recognize by consistent differences in flash sig nals, and later found to differ in mi nor details of body color. In many places two or more species of *Pho tinus* fly together, but they are pre vented from interbreeding by thei different light signals. The males fly at different heights and in different flight patterns; their flashes differ in length, in the number of pulses pe flash, and sometimes in the color or intensity of the light. The male is saying, in Lloyd's words: "Here I am in time and space, a sexually mature male of species X that is ready to mate. Over." The female of "species X" responds with a flash at the interval characteristic of her species. Lloyd was interested in learning how much latitude was permissible without causing "misunderstanding." In his experiments he used electronic devices for producing artificial flashes of known duration as well as for accurately measuring the response delay of the females. As in the case of crickets—and in fact all "coldblooded" animals—things happen faster at higher temperatures, so in all his work temperature had to be taken into account.

Continued on page 68

A tree on a riverbank in Mala is ablaze with the light synchronously flashing firefli

The Turkmen

Until a century ago, Turkmen nomads migrated seasonally over the Central Asian steppe in search of pasture, their mobility preserved by their independence from neighboring sedentary governments. Today they have lost their independence, but in remote areas many still cling to their nomadic way of life.

The Turkmen inhabit a region divided between three countries—Afghanistan, Iran, and the Soviet Union—and their population is a million and a half. Although they have all been brought under the control of these countries, conquest and settlement were accomplished piecemeal, affecting some areas sooner and more drastically than others. Among those who have remained nomadic, tradition is largely intact, and when I began my study of the Turkmen in the winter of 1965, I decided to concentrate on this group.

The devotion of these people to a migratory way of life can be understood only in historic perspective. The Turkmen are by tradition a pastoral people, and for them nomadism is a way of using sparse and seasonably variable pasture for livestock production. But it was, in the past, something more: a means of resisting firm government control. Such resistance was a consciously maintained tradition among the Turkmen, and nomadism was the chief means to this end.

Their eagerness to resist the power of sedentary states grew out of an understanding of what government control meant to settled people. In the harsh social environment of the traditional Middle East and Central Asia, settled people were frequently exploited through the imposition of heavy taxes and rents.

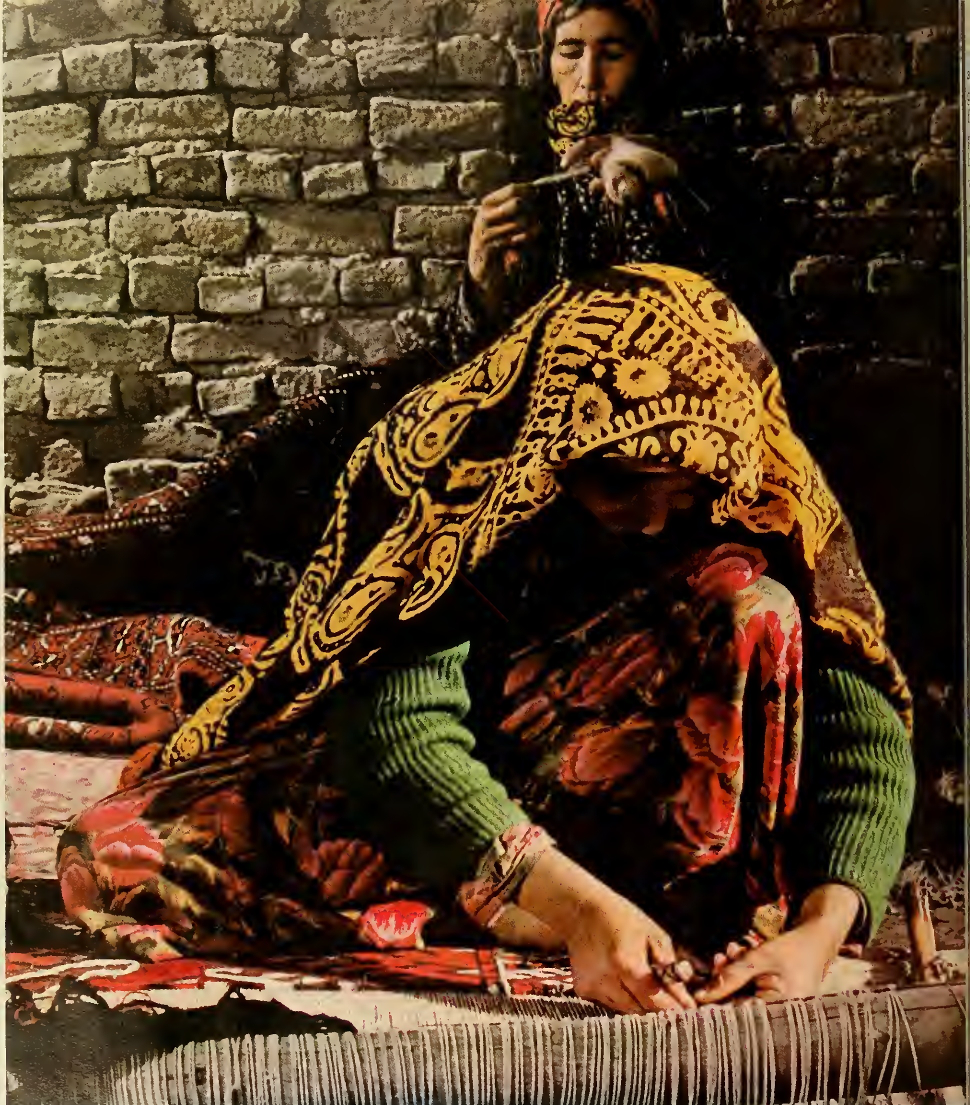
The Turkmen not only avoided such exploitation, but by raiding and collecting tribute from their sedentary neighbors, they went a step further and put themselves in the position of the exploiter. A century

Iomads by William Irons

ago they were notorious as brigands and especially as slave raiders. Slaving activities were conducted primarily in northeastern Persia (now Iran): Turkmen raiding parties ambushed caravans or attacked villages, retreating quickly with their captives to their own territory.

The portion of the Central Asian steppe inhabited by the Turkmen stretches east from the Caspian Sea to the Amu Darya, a large river that empties into the Aral Sea. The central part of this area is the Kara Kum, or "black sand," a vast, largely uninhabited and uninhabitable desert. The majority of the Turkmen are concentrated in two somewhat more fertile regions bordering the Kara Kum. One area consists of the banks of the Amu Darya; the other is a long strip of plains and low mountains, lying south of the Kara Kum and separating it from the Iranian Plateau. My study was carried out in a section of the latter area—in the Gorgan Plain of northern Iran.

All nomadic Turkmen are divided into residential groups known as



This woman weaves one of the valuable carpets that provide th[e] community with a cash income, while an older woman spins yar[n]

obas, and my research was focused on a single *oba* consisting of sixty-one households. This group migrates within the Gokcha Hills, a patch of low hills that protrudes into the Gorgan Plain. An *oba* is associated with a definite territory, and all of its members share common rights over that territory, including the right to use the pastures and any natural source of water there. All have the right to dig wells, but once such wells have been dug they become the private property of the persons who expended their labor in digging them. Similarly, all may plow up virgin land for cultivation, but once someone plows a section it becomes his private property.

Throughout the year these nomads live in yurts, a Central Asian tent, which consists of a hemispherical wooden frame covered with felt. They make their living primarily by raising sheep and goats, and their pattern of migration is largely determined by the needs of their animals and by variations in pasture and water supply. The climate of the Gorgan Plain is characterized by definite wet and dry seasons. The wet season begins in the winter, and during this season the Gokcha Hills and surrounding steppe are covered with

a short, but relatively thick, crop of grass giving the appearance of a vast, freshly mowed lawn. Winter temperatures are mild, rarely dipping below the freezing point. The rainwater, as well as occasional melted snow, collects in scattered depressions to form pools from which water is taken for household needs. During this season, the nomads camp where water and suitable pasture can be found. Ample pasture is usually available close to their dry-season location, so that most of their migrations are quite short. In this respect, they differ considerably from many of the pastoral peoples in and around the Iranian Plateau who make long seasonal moves ranging over vastly differing ecological zones.

Among the Turkmen, the seasonal migrations of camps differ from the movements of livestock. The nomad camps of the Gokcha Hills alternately collect at wells and disperse over the surrounding territory, while the livestock move between the Gokcha Hills and the Gorgan River, thirty miles to the south, thus covering a larger area. This means that the Turkmen camp near their herds only during a portion of the year.

The reason for this lies in the needs of their livestock. During the latter part of the winter, the lambing season begins and the Turkmen must be near their herds to assist in cases of difficult birth and to care for the lambs, which are kept inside the yurts at night to protect them from the cold. Because the lambs are too weak to travel far, they must be pastured near the camp. Even after the young animals are weaned, the adult females must be milked daily, and for this reason, the nomads still keep the livestock near their camp.

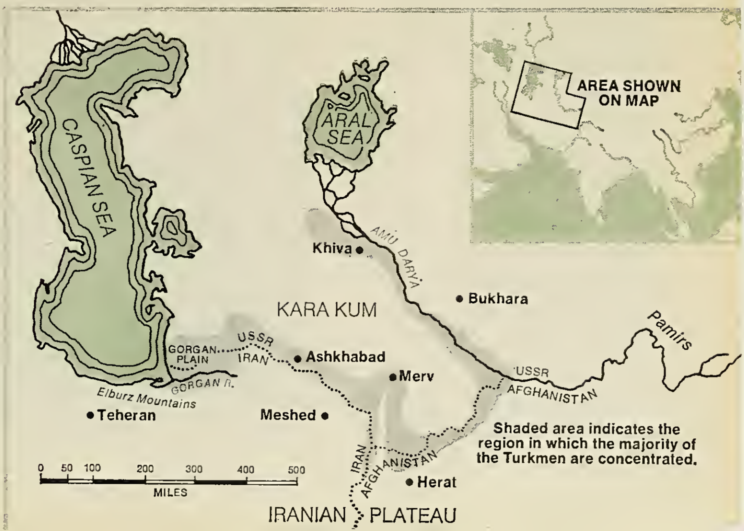
With the onset of summer, the dry season begins, and the green pastures of spring are gradually transformed to a barren brown. The rainwater pools disappear, and now the nomads must camp near their wells. When the pastures become sparse and desiccated, the animals stop giving milk, and it is no longer necessary to keep them nearby. They are then sent south to the banks of the Gorgan River, where they graze the stubble of harvested fields. The younger men of each household accompany their family's livestock and live separately from the rest of the household, with only a small lean-to-like tent for shelter.

This division of labor is possible because herding, as well as other forms of economic production, is organized by extended families, consisting of an older man and his wife, his married sons with their wives and children, and his unmarried sons and daughters. Each family produces only a part of what it consumes: milk and milk products, meat, felts and carpets for their yurts, and a small amount of grain. In hope of a late spring harvest, wheat and barley are planted during the winter in valley bottoms or other depressions where water tends to collect. This is a gamble, however, since often the crop does not develop, but when a crop can be harvested, the yield is generally sufficient to make up for the losses of grain put down as seed in bad years.

The rest of their needs must be purchased. Cash income comes from the sale of wool, felts, carpets, and animals for meat. The basic item in their diet is bread, and they purchase the bulk of the wheat from which the bread is made. Rice, tea, and sugar must all be bought. Clothing, cloth, metal tools, and nowadays, a hand-powered sewing machine and a transistor radio. are other items that a typical nomadic Turkmen family buys. About once a month, two or three men from each *oba* travel to the nearest city to purchase supplies and to sell their products: animals, wool, and carpets. Thus, the pastoral economy of the Turkmen is market-oriented, even though production is organized along family lines.

The organization of the extended family reflects a strong emphasis on descent in the male line, which runs through all Turkmen social institutions. When a man's daughters marry they go to live with their husbands' families, whereas his sons bring their wives into his household, where they assume the dual role of wife and daughter-in-law. A man's grandchildren in the male line grow up in his household, and he commonly refers to them as his "sons" and "daughters." When, with the passing of generations, his grandsons become old men and the heads of extended families of their own, they will camp together and co-operation between them will be extensive. If any one of them is offended by an outsider, the group will band together to seek redress. Small patrilineages of this sort provide the model in terms of which the larger political units of Turkmen society are organized.

The older men, who make the important decisions, know their genealogies well. Each of them can, on the basis of his genealogy, identify a group of people who share with him a common ancestor in the male line four generations back, and a slightly larger group of people descended from a common ancestor five generations back, and so on, until he



has identified himself with descent groups including thousands of families. Ultimately all Turkmen believe they are united by their genealogies as the descendants of a single man, Oghuz Khan. Although the remoter generations of these genealogies are vague and legendary in character, this is of no practical importance since the Turkmen take them seriously as a basis for arranging their social obligations.

Traditionally, the primary function of these descent groups was defense of the individual's rights through violence, or the threat of violence. Defending one's patrilineal kinsmen when their rights were violated was a basic duty in Turkmen social life. This was extremely important, because the absence of state control and of tribal offices with sufficient authority to enforce law and order meant that the strength of a Turkmen's patrilineage was the only guarantee of his rights.

When someone violated a Turkmen's rights by robbing him, injuring him, or killing him, his patrilineal kinsmen were obligated to seek redress by whatever means was necessary, even including violence. In cases of murder, for example, either the murderer or one of his lineage-mates was killed in revenge. Who sought redress for the victim and who defended the culprit were matters determined by genealogy and by the gravity of the affair. Small problems could be handled by the immediate families of the victim and the culprit. As matters increased in seriousness, a wider and wider circle of people who shared common patrilineal descent was called upon for assistance.

Those who were, on the basis of their genealogy, close to neither party also had a prescribed role. It was their obligation to attempt to bring about a peaceful settlement and, if possible, to prevent bloodshed. If the offense was slight, they merely advocated peaceful discussion and suggested compromise. In cases of murder, the neutral party aided the culprit by hiding him from the victim's kinsmen and by helping to arrange his escape to some distant place of refuge. Protecting those who came seeking refuge was part of the obligation of neutral parties to prevent bloodshed. The Iranian government has been attempting to eliminate this traditional system of self-help and to enforce law and order itself; in remoter areas, however, it has not always been successful.

The composition of Turkmen *obas*, like many other aspects of Turkmen social structure, reflects the importance of patrilineal descent. Most of the men of any *oba* are closely related in the male line; in addition, there are usually a number of unrelated families who have come to the *oba* fleeing feuds in their home territory. While these refugees reside there, the *oba* will protect their rights of person and property against outsiders.

The men of an *oba* traditionally selected a headman, who took charge of all dealings with the outside world. Today, in theory, he is appointed by the government, but in practice the local officials usually allow the men of the *oba* to indicate the man they want as their headman. The headman has no authority, but merely acts as a spokesman for the *oba* as a whole. Any important decision must be based on consensus; it must be preceded by discussion by all the men of the *oba*. Usually a headman is selected for his intelligence and integrity and for his ability to speak Persian, the language of the government officials with whom he must deal.

Ordinarily a group of fifteen to thirty *obas*, which belong to the same

Sheep are sheared twice a year, and the wool is spun into yarn, dyed, and hung on yurts to dry. Below, a woman milks a ewe; milk and mutton are important subsistence products.

Turkmen exercise their horses, above, by holding afternoon races. Below, a woman lashes together the frame of a yurt. Assembling the yurt is a woman's job, although men help when many hands are needed.

descent group and occupy contiguous tracts of land, form what the Turkmen call an *il*, a word best translated as tribe. In the days of intertribal warfare, the *obas* of such a tribe were usually on peaceful terms with one another. Tribes that adjoined were usually hostile, and there was much raiding between them.

One of the functions of the Turkmen tribe that has not survived government control is the practice of protecting neighboring sedentary villages. These villages were especially vulnerable to the raids of the Turkmen, and to gain a measure of security and protection each village paid tribute to the Turkmen tribe nearest it. In return, the tribe agreed not to raid the village, and to prevent raids by other Turkmen tribes. They also agreed to compensate the village for losses if they were unsuccessful in preventing raids by other tribes. In effect, the exchange of protection for tribute was a peaceful substitute for raiding.

The Turkmen were able to resist government control, to raid, and to collect tribute because their nomadic way of life made them an effective military force. They were good horsemen and were well supplied with horses. Raids, both of sedentary villages and of other nomads, were frequent events and provided the Turkmen with excellent military conditioning. When clashes with the Persian military forces occurred, normally hostile tribes would unite to turn out a large body of cavalry. This seasoned cavalry could usually hold its ground against the Persian forces, but even when met by superior strength, the Turkmen did not surrender. Instead, they would retreat into the desert north of the Gorgan River, taking their families and livestock with them.

Thus, mobility preserved the power and independence of the Turkmen; this was why they consistently avoided anything that would compromise it. Much of the territory they inhabited was naturally fertile and was crossed by numerous streams. The construction of irrigation works and the practice of intensive agriculture could have made this land more productive. Permanent houses at their dry-season locations could have increased their comfort. The Turkmen, however, would not accept such trends away from nomadic life. They concentrated instead on livestock production, on raiding, and on the collection of tribute.

During the last century, the political independence of the Turkmen has gradually been whittled away. Advances in military technology have shifted the balance of power between the nomadic tribes and settled society and have led to the conquest of the nomads by sedentary powers. Most of the Turkmen were conquered by the Russians during the latter half of the nineteenth century. Those on Iranian soil were subdued and brought under firm control in 1925.

The objective of conquering governments has been to encourage a transition to a more sedentary and peaceful way of life. Such a transition, however, could rarely be accomplished at once. The nomads viewed settlement as a consolidation of governmental authority over them, and were not eager to take up sedentary life. For this reason, in the thirties the Iranian government began a policy of forced settlement not only of the Turkmen but of all of the Iranian tribes. The nomads I studied had been forced to build permanent houses at their dry-season locations in 1936. For five years, under the watchful eyes of government authorities, they lived in these houses during the dry season and migrated with their yurts only during the wet season. This form of semisedentary life developed naturally out of their pattern of pasturing sheep away from their dry-season camps. That it caused no economic difficulties is revealing. The nomads had maintained a completely mobile existence for political rather than for economic reasons, and a transition to a semisedentary existence could be made without economic difficulty.

In 1941, Russia occupied northern Iran because it was fearful of Iranian co-operation with the Germans, and the process of settlement was reversed. The Iranians had been interested in modernization, but the Russians were interested only in sufficient order to keep their supply lines to their Western allies open. Many of the Turkmen who had resented forced settlement reverted to nomadism. The people with whom I recently lived destroyed the houses they had been forced to build and returned to living year-round in yurts. Security deteriorated, and banditry became rife in the remoter and more arid regions, such as the Gokcha Hills.

After the Second World War, the authority of the Iranian government was restored in the Gorgan Plain and efforts to modernize the Turkmen were renewed. The government had come to understand the limited value of the type of force measures used in the thirties. Its objective was not to reduce the Turkmen to the traditional position of exploited peasantry, but rather to integrate them into a society that was on the way to becoming a modern nation. This meant the terms would have to be satisfactory to the Turkmen themselves. In line with this policy, persuasion was used rather than force.

Great progress was made in the fertile and populous region south of the Gorgan River.

In the Gokcha Hills, things changed more slowly. By 1960, the government had eliminated banditry, clearing the way for further progress. The Turkmen of this region, however, have remained nomadic to the present. Nevertheless, there are indications that they too will eventually be caught up in the trend of modernization.

The Gokcha Hills Turkmen are beginning to realize that their nomadic way of life has no place in the future. In 1967, when I left the *oba* that I had studied, their headman had begun to discuss the need of a school for their children. He is an intelligent man, aware that his own children will have new opportunities if they become literate. He is convinced, however, that they cannot persuade a government school teacher to live in a community that consists only of yurts. He has been telling the men of his *oba* that they need a school, and that in order to have one they will have to build houses as they did in 1936.

The headman will find that winning the men of his *oba* to this view is a difficult task. Eventually, however, they will build houses and a school, and ultimately they will be drawn into the mainstream of Iranian national life.

Camel, above, is loaded for a migration. Two camels can carry an entire yurt—the wooden frame on one; the felt covering and cane siding on another. Oxcarts, below, are often used where land is flat.

The King Besieged by Jack Hope

Standing upon one of the treeless peaks that surround California's Mineral King Valley, surveying the wilderness of the southern Sierra Nevada, provokes a certain spirit of uneasiness. The feeling is not unpleasant, but is disturbing only in the sense that it is one that we aren't used to dealing with.

I don't think it's the height that brings about the sensation, or the vast abyss that suddenly opens in front of you. Nor is it simply a product of the powerful alpine panorama. More than anything else, it seems to stem from a feeling of inappropriateness on the onlooker's part. But then —perched atop a mass of granite that thrust its way from the earth's crust 30 million years ago; gazing down from a height of 12,500 feet upon an incredible array of jumbled, snow-streaked peaks, alpine meadows, and evergreen-covered mountainsides; recalling a passage from the guidebook, which notes that 200 million years earlier this land rested at the bottom of a sea—what can you do that "fits" the occasion? Take a picture? Identify wildflowers?

I don't mean to imply that Mineral King (commonly known as Mineral King National Game Refuge) is unique. In fact, most of the Sierra Nevada contains similar features—the mountains and the giant sequoias, the glacial lakes, and the wide eyed mule deer. However, as wilderness (with the exception of a few hundred acres) it is at least exceedingly rare. For in the United States only about 2 per cent of our land falls into this "wild" category—about one-fourth the area now taken up by cities.

One of your first reactions to Mineral King is that you would like to show it to others who have not had the chance to see it. Your friends primarily, but others as well: a delegation of lawmakers, perhaps, or the boys who drive grocery carts around Manhattan. It seems that if more people could see such places, the job of caring for them would be much simplified—people would want to protect them for themselves, for their children, and for their friends.

There is some truth to this thought, but there is a great naïvete as well. For wilderness is by definition a perishable commodity. It can easily be loved to death in the attempt to display it to the greatest number of people. Building roads, for instance, to "make wilderness more accessible to the millions"—despite its democratic overtones—is self-defeating; something like carving up Michaelangelo's statue of "David," so that each of us might own one splinter.

For another thing, not everyone looks at the land in the same way. Mineral King's 15,000 acres are regarded by different people as a setting for a beautiful photograph, a hike, a fishing trip, or as a place for the study of biology. Some see the terrain as ideally suited for a ski resort, while others welcome the wild country as a means of getting out of contact with other people for a few hours or a few days. There are those who classify the land and its creatures as "natural resources" to be used for the generation of income; and some who regard it as important in itself—whether or not it is seen, smelled, heard, touched, or tasted by humans—its own reason for being.

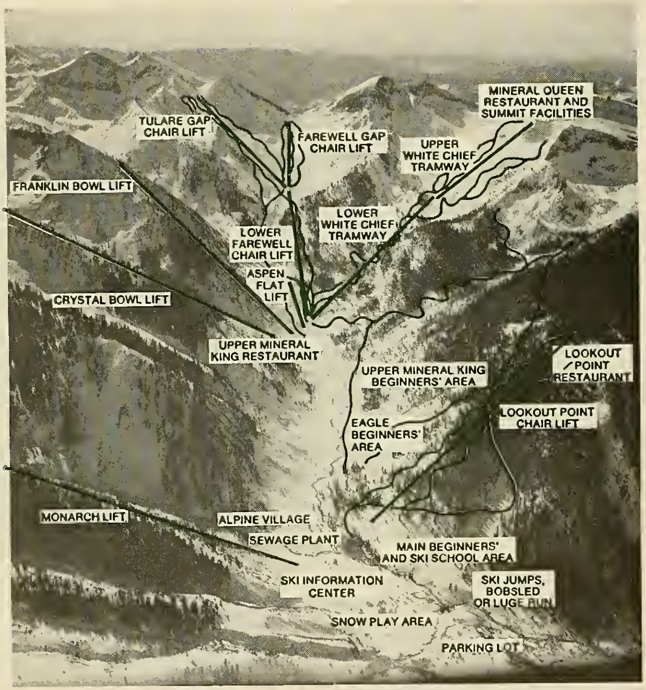
Each group has its own notion of what should, or should not, be done with the land, and as you might guess, these notions conflict at least as often as they coincide. Yet, within the past 20 years, each faction has come to regard itself as the champion of a cause called "conservation" (whether their real interest lies in hiking, in hunting, or in cutting trees). This is the situation at Mineral King, where, within the next few months, the proponents of one of these viewpoints will be awarded the privilege of shaping the future of this region according to their own conception of this popular term.

On the surface, it is not always clear whether a group's choice of the conservationist label is appropriate—whether it stems from a misuse of the dictionary, or whether it is, in fact,

Mineral King National Game Refuge looks much as it did five thousand years ago. The Forest Service and Walt Disney Productions plan a $35 million recreation resort for this area.

Civilization's inroads are modest at Mineral King. Hot showers, groceries, and local news are available to summer visitors at "the store" in Mineral King Valley.

Seen from one of the trails leading from Mineral King Valley, a summer storm unfolds above the peaks of the Sierra Nevada.



Portions of the planned Disney resort and ski facilities superimposed on aerial view of Mineral King (above). Maps show location and detail of Mineral King National Game Refuge. The proposed new highway (276) would closely follow the present access road.

a product of a good public relations department, which knows that the word has a high "acceptance value." The story of Mineral King may be instructive in this regard; may serve as a prism through which the apparently single beam of "conservation" can be separated into its components for the purpose of closer examination.

In February, 1965, the Department of Agriculture's Forest Service issued a *Prospectus for a Proposed Recreational Development at Mineral King in the Sequoia National Forest.* The purpose of this rather stark little document was to solicit bids from private developers for the privilege of constructing and operating a year-round recreation resort within the Mineral King National Game Refuge, a 15,000 acre neck of Forest Service land protruding into the southern boundary of Sequoia National Park. In addition to serving as a wildlife refuge, the region is now used for a variety of activities—camping, hiking, fishing, and sightseeing.

This is not a new type of activity for the Forest Service, whose guiding principle of land management is that of "multiple use." What this term means in regard to the natural environment is that the Forest Service is sanctioned to be one degree less protective than is an agency such as the National Park Service. Thus, on the 187 million acres of public land administered by the Forest Service, a wide variety of activities are permitted, including lumbering, hunting, livestock grazing, mining—even some private cabin building.

And within the last decade the focus of national attention upon the country's recreational potential, combined with the spiraling magnitude of the billion dollar recreation business, has "sensitized" the federal government's largest landholding bureaus to the task of accommodating a prodigious number of

On its descent from Mineral King into the San Joaquin Valley, the east fork of the Kaweah River leads through groves of giant sequoia, sugar pine, and incense cedar.

special recreation interests, ranging from motorboating to motorcycling and from skiing to skimobiling. Toward this end, the Forest Service has undertaken to make much of its domain available for a multitude of uses, and in the case of skiing, has leased public lands to commercial developers who now operate such well-known ski meccas as Aspen, Vail, and Sun Valley in the west; and Mt. Snow and Sugarbush in the east.

Thirty-seven of the 190-some ski areas on Forest Service land are located in California—more than in any other state. Nevertheless, that state's current population of about 19 million is growing rapidly; it is expected to reach about 25 million in 1976, and perhaps 40 million by the year 2000. The use of the state's outdoor recreation facilities—both winter and summer—is undergoing an even more rapid expansion. The Forest Service predicts that use of California's national forests for winter sports alone will climb from the present level of about 2 million annual visits to 6 million in 1976 and 12.4 million in 2000.

An interesting aspect of the country's recreation "boom" is the extent to which it is a middle-class (or at least a "non-lower" class) phenomenon. Participation in even the simpler forms of outdoor recreation calls for a certain income level. Gaining access to a national park or forest, for example, is frequently contingent upon automobile ownership. And such pursuits as skiing, motorboating, and the more elaborate forms of camping require a considerable investment to purchase and operate the necessary equipment, and perhaps to pay for the privilege of using it.

The typical ski-family in the western states, for instance, has an annual income of $9,500 ($2,000 above the average income for that area); an adult member of this family owns about $300 worth of ski equipment, and spends over $20 per day on his ski trips. Sporting-goods salesmen, restaurant owners, and motel operators are fond of these people.

In addition to their relative affluence, ski enthusiasts are generally well organized, vocal, and therefore influential, even though they make up only 1 to 2 per cent of the total population. And, like many special-interest groups, skiers have regular means of broadcasting their requests that new regions be opened to their sport—the many ski magazines, the political friends, and so on.

Influences of this sort play a part in the decisions made on what to do with the country's public land. Some twenty years ago, for example, the Forest Service decided to develop Mineral King Valley, hoping perhaps to relieve the pressure skiers were exerting to have other areas opened, such as the San Gorgonio wilderness in southern California.

But in 1949, when the first attempts were made to attract private capital to develop Mineral King, no bids were received, because the only access to the area was, and still is, a serpentine, twenty-five mile road leading from the San Joaquin Valley

Continued on page 72

More than twenty lakes within Mineral King's boundaries were scooped from the granite of the Sierra Nevada by the grinding action of a glacial ice sheet.

Culture and the BE

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Industrious, but inefficient, beavers keep water levels safe by overworking, not by transmitting learned strategy from one generation to the next

by Anthony F. C. Wallace and Virginia L. Lathbury

One hundred years ago, Lewis Henry Morgan, the foremost American anthropologist of his day, published a book about beavers. This monograph, *The American Beaver and His Works*, based on Morgan's own field studies of beaver construction behavior, became a classic. It is still cited by scholars, but until now, so far as we know, no other anthropologists—and few ethologists—have undertaken to follow up its leads and test its interpretations. This is a pity, for Morgan had found an appropriate animal subject for the study of what he clearly understood to be a basic scientific issue: whether animals other than man "have culture," and if so, what kind of culture.

Anthropological dogma, then as now, generally has held that only man and perhaps some of the higher primates have been able to transmit learned adaptive information across generations (i.e., "have culture"). Morgan refused to accept this anthropocentric view and insisted to the contrary that the behavior of lower animals, although obviously less complex and sophisticated, was governed by the same principles as man's. These principles of behavior included culture and cultural progress. Rather than rely on genetically inherited "instinct" (a concept he regarded as having little explanatory value), he argued that animals such as the beaver reason from experience and accumulate shared knowledge over generations:

> Many animals, as the elephant, the horse, the bear, and even the hog—the type of stupidity—have been taught a variety of performances, under the stimulus of rewards, of which they were previously ignorant. These examples, however, are less important than the knowledge acquired by undomesticated animals, and transmitted, as a part of their experience and knowledge, in the species in which they were acquired. Of this kind are the several varieties of the beaver lodge and dam, and the development and perpetuation of the idea of a beaver canal.

In recent years, both within and outside anthropology, an increasing number of research enterprises have—to use the useful cliché—broken the anthropocentric barrier and objectively considered the cultures of animals other than man. Scientists have investigated cultural innovation and diffusion and interband cultural differences among Japanese macaques; they have observed chimpanzees and vultures using crude tools; they have studied the signal systems of a variety of creatures (and not merely the speechless dolphin) with a growing awareness that language is not prerequisite to social communication. Psychologists have professed to discover "religious" ritual developing in frustrated pigeons; ethologists have devotedly investigated the learned social behavior of fishes, birds, and mammals. We anthropologists have contributed to this understanding particularly in the study of non-human primate behavior, and the word "culture" is, indeed, being used more and more, although still cautiously, to refer to some of the behaviors observed among the lower creatures. Indeed, it seems likely that the word may one day be used without the user being automatically convicted of the "pathetic fallacy" of reading human motives and calculations into the behavior of innocent animals.

Although in our view it is reasonable to assume a continuity of the culture principle across broad taxonomic categories, the empirical questions remain. To what degree do the lower animals calculate rationally in human terms? Do they learn skills and pass them on from generation to generation? In what ways are genetically determined instinct, individual learning, and group culture combined in animal behavior?

Morgan's theory that the beaver both learns and transmits skills grew out of several years of studying beaver construction, but he made few observations of actual beaver

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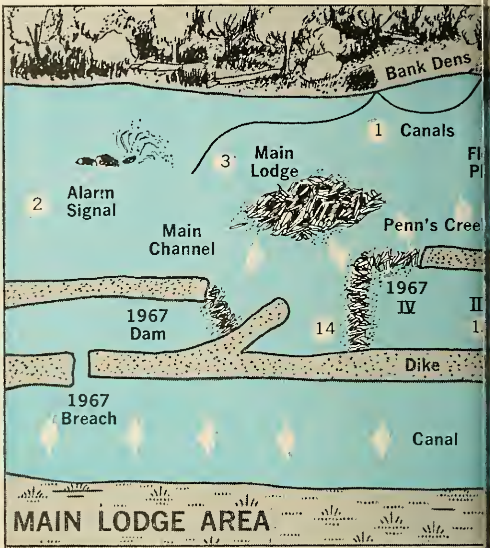
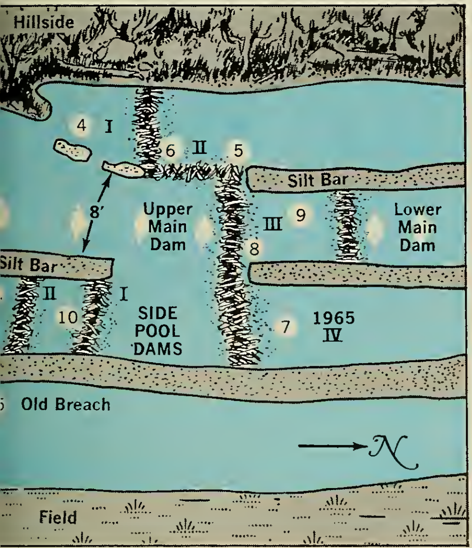


activity. As an anthropologist. he had an acute interest in material culture, and his study of the beaver also focused on material culture—dams, lodges, canals, tunnels, and slides. He carefully described and analyzed the earthworks of several colonies in Marquette County, Michigan, near the tracks of the Marquette and Ontonagon Railroad, of which he was a director. He spent most of the summers from 1855 to 1867 studying beaver works in the county, dissecting the dams and lodges, measuring the canals, examining cuttings, making maps and sketches, and photographing some of the more impressive examples. Like most woodsmen, he recognized the adaptive value of these works, in certain ecological situations, to a mammal that depended upon water for protection from predators. Beavers could and did survive on occasion beside ponds and along streams simply by living in burrows, without the usual elaborate system of dams, lodges, and canals. But Morgan saw that the construction system functioned efficiently to permit larger numbers of beavers, in less favorable terrain, to forage for food, to reach timber for cutting, and to enter and leave the nest without traveling more than brief distances over ground.

How did the "architectural mute" ever come to manufacture such a useful and human-like environment for himself? To Morgan, it appeared that the transfer from "a natural to an artificial mode of life" could only have been effected "voluntarily" as a result of a mental process akin to what humans call "thought." Not that he was blindly anthropomorphic; he spent much time disposing of folkloristic and overly rational interpretations. Nonetheless, when he considered the impressive fit between form and function, and the skill and labor involved in building and repair, it was difficult for him to avoid either the notion of intent or the notion of learned, socially transmitted skills (culture).

Our study of the beaver colony near Philadelphia, however, suggests that the hydraulic engineering of wild beavers is governed by hormonal and seasonal factors, and that the over-all design of a colony's earthworks is a product of haphazard circumferential expansion rather than foresighted strategy. The work is inefficient and random by human standards, but because there is a great deal of work done, it is usually sufficient to maintain higher water levels in the ponds than nature alone could provide. While this conclusion denies that beavers possess a human-like culture in regard to site planning, it does not rule out the possibility of transgenerational transmission of learned skills in the mechanical details of construction.

The colony we observed is located on a creek about thirty miles north of Philadelphia. (We will use the pseudonym Penn's Creek for this stream in order to protect the beaver colony from tourists or irresponsible trappers.) The stream empties into a century-old canal, which flows alongside the Delaware River between Philadelphia and Easton, and the portion of the stream inhabited by the beavers is separated from the canal by a man-made dike. The Penn's Creek colony, according to the testimony of local farmers and canal maintenance personnel, was begun about 1955 or 1956, after the beaver colonies immediately up-



Penn's Creek Study Area

Photographs on these and the following pages are numbered to correspond with features on the map of beaver colony, left.

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stream were abandoned. possibly as a result of an exhausted wood supply. Occasionally, the colony is harassed by local hunters and. when the beavers dam the canal. by the maintenance personnel. Nevertheless, despite the existence of a legal beaver-trapping system in Pennsylvania. there has been no systematic trapping for pelts. and the animals have been left relatively undisturbed. perhaps as a result of sentimental interest among local residents.

The focus of our investigation was. as it had been with Morgan, the construction activity of the colony. The junior author was responsible for the work of observation, and from October, 1964, through August, 1967, during all seasons, Mrs. Lathbury spent approximately 750 hours observing the beavers and studying their construction, making maps and sketches, recording repair and new work, and photographing the animals and the site. She visited the site two or three times a week, and even in winter never stayed away for more than ten days. Because of their shyness and aquatic habits, it was not possible to make an accurate census of the beavers or to identify individuals: this difficulty. as in Morgan's case. made useful analysis of social organization and social behavior impossible except for the broadest generalities. Nonetheless, Mrs. Lathbury was able to make friends with the animals and by the third summer could hand-feed apples and twigs to the young beavers while the adults watched from two or three feet away. We estimate that the colony, during the period of study, contained an average of four adult pairs and their one- and two-year-old offspring. a total of about twenty-five individuals.

Our interest fixed early on the relationships among type and intensity of construction work, stream water level, and breeding cycle. Knowledge of these relationships appeared to be necessary before we could estimate the congruence between beaver and human "logic" in water engineering. Granting that the essential function of beaver dams and other construction is to provide a depth of water sufficient for protection from predators. it is reasonable in human logic to concentrate maximum effort on conserving water during seasons of minimal water flow. At Penn's Creek, low water occurs during the summer and fall, and we expected to find, in accordance both with human logic and previous studies of beavers (including Morgan's), that our beavers would work with increasing vigor during these seasons, as the need to conserve water behind dams became more and more critical. To our surprise. we found that precisely the opposite was true. It was at exactly the time of highest stream levels that the colony was most active in construction work. At Penn's Creek—as is the case over most of the areas of North America. Europe. and Asia where beavers are native inhabitants—stream flow reaches a maximum in the spring, as a result of the early spring thaw plus rainfall, and is at its lowest in summer (*see graphs*). The flurry of construction activity in the spring consisted of assiduously repairing dams breached by high water and of raising the level of these dams to match the increased depth of stream. In the other seasons, to be sure. some new work was observed outside the main dam system, and occasional emergency repair was also seen (in the upper main dam system

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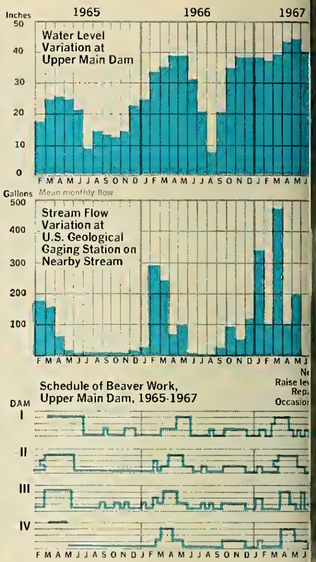

in January, 1967, for example, when rain and thaw caused high stream levels); but the distribution of effort over time was not optimal in relation to our human conception of water conservation effectiveness. Thus breaches in one dam might remain unrepaired for months while holes in a lower dam were filled; and on one occasion extensive labor was spent constructing and repeatedly repairing a new dam across the canal, which was periodically broken and removed by canal crews.

The beaver geography of Penn's Creek was constantly shifting. Lodges and dams were abandoned, new dams built, bank dens dug and improved, side pools impounded and then left to drain through unrepaired breaches, while water levels behind the dams varied dramatically. In no sense could it be said that the system of waterworks maintained a constant level of water; it merely succeeded in generally maintaining wider and deeper pools than would have filled the stream bed without the dams. The water level at the base of the main lodge, for instance, as measured on a striped iron pipe planted for the purpose, varied through a total range of 39 inches during the period of observation, the highs regularly occurring from December through June. Indeed, at times in summer some of the pools behind the dams were almost empty, with the little remaining water escaping quietly through breaks and percolating through the base; yet even then the animals would do no repair work with mud or sticks for weeks at a time.

The core of the Penn's Creek colony was the main lodge and the system of dams around it (*see map*). The main lodge, located on a spit of land that became an island in high water, was about six feet high. Each year it was enlarged with an application of mud and sticks. The main dams that conserved its protecting reservoir were raised in height each spring, in a feverish effort to stop the high water from running over the crests. The effect of raising the main dam system, of course, was to raise the water level around the whole perimeter of the pond during periods of high streamflow. This resulted in periodically increasing the erosion rates at small supplementary dams and at the man-made dike and in starting new overflow points. And so, a whole new cycle of repair, and eventually new construction, was entailed by each successful effort to raise the height of the main dams.

The strategy employed in the process of circumferential repair is revealing in regard to beaver "logic." One of the chronic problems of the main lodge water-control system was an old breach in the narrow dike that separated the north-flowing creek from the south-flowing canal. Between this breach and the main lodge lay a narrow bar of land, which had been deposited there years ago by dredging crews removing silt from the canal bed. Before Mrs. Lathbury's arrival the beavers had sealed off this hole, not by planting a dam across the breach itself, but by damming off the water's access to the breach by a system of no less than four dams between the bar and the dike. These dams were regularly repaired and raised, but the constant erosion of the undammed old breach finally worked back and undermined the two nearest dams, and they were eventually abandoned. The

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Upper and Lower Main Dams

Contrary to expected behavior of conserving water in dry season, beavers worked hardest at raising dams during spring floods (see graphs, left). The deep pools that resulted gave newborn kits maximum protection from predators.

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nal maintenance personnel, who so wanted to stop up this leak, ilt their own dam by setting a ank across the breach. But the avers, in an irregular and only rtly effective way, attempted to pair the whole system of interven-g dams, even though far less effort the breach itself, only a few yards rther on, would have accomplished tter results.

These observations revealed a ttern of work so much at variance th some of the reported norms of aver behavior and so inconsistent th assumptions of a humanly ra-nal allocation of effort that we ught other explanations.

An outstanding fact soon emerged om our calculations. For the Penn's eek beavers three events had coin-led in time—the period of high eam water, the period of gestation, d the period of maximum con-uction activity. The coincidence of ese ecological and biological events ggests an obvious interpretation: at the principal function of the ms is to maximize the water level ound the lodge at precisely that time of year when the mother is pregnant, gives birth, and is nursing the infant in its most helpless and vulnerable state. It is apparently the case with all beavers that mating occurs in late winter (streams are frozen then in the north), and the kits are born in late spring. In the beaver's northern range, as well as in most of its southerly range, spring is also the time of high water in the streams, irrespective of seasonal rainfall distribution. The concen-tration of work on dams during the high-water period may not be the most effective way of spending energy on dam work, if one considers the problem of the later dry season. But it does have the effect of increas-ing the water depth around the lodges and prolonging the high-water season at precisely the time when the young are most vulnerable to predators.

How are the Penn's Creek beavers (and perhaps others) prompted to mobilize maximum effort at this time? It could, of course, as Morgan suggested, be a "cultural" tradition, passed on by imitative learning. But a more reliable mechanism suggests itself. The sound of running water is a stimulus to which beavers do re-spond with construction or repair activity at any season. This is at-tested to not only by folklore and anecdote but by the reports of the French ethologist P. B. Richard, who during the past decade has conducted careful studies of beavers in a re-stricted but nearly natural environ-ment. It seems probable that the beavers' sensitivity to this stimulus is heightened by hormonal changes as-sociated with gestation.

If one considers the construction activity in this light, the beavers' dam maintenance activity appears to be an aspect of what may loosely be called a nesting instinct. Just as natural selection has favored those beavers that gestate and give birth during the time of highest stream water in the northern hemisphere, so it has further favored the survival of those colonies that are spurred to maximize the security of the young by building up the height of their dams during the spring floods. This "instinctual" timing of effort does not result in the most effective main-tenance of water levels during the dry season, although any pattern of annual repair preserves a higher

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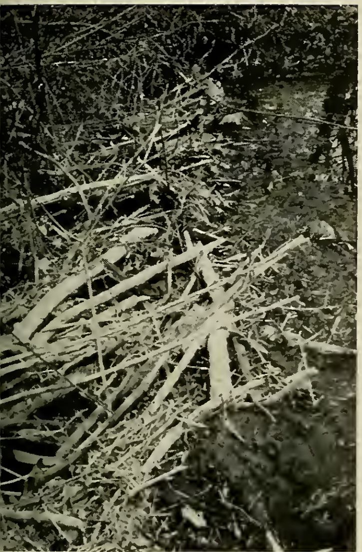
reservoir than would be available without the dams. But given the simple methods of construction and repair available to the beaver, it is no doubt the most effective method available to insure survival of the next generation—which is, after all, the one essential task.

A further inference that must be made from our observations is that the effectiveness of the dam construction and repair work of the beaver is governed by the laws of probability: that is, although the level of effort is determined by hormonal and seasonal factors, and the location of effort is hit-or-miss rather than rationally planned, the amount of work is sufficient, over the course of a year, to affect a material improvement in water level around the lodges. Much of the work is wasted and many opportunities are missed; but even if only a small percentage of the work is effective in improving water level, so much is done that it is generally sufficient to satisfy the need. If it is not, of course, the colony either dies out or migrates.

And finally, a consideration of the order, observed over several seasons, in which beavers attack various water-control problems suggests (not surprisingly) that they do not plan strategic moves in advance after perceiving surrounding territory as a whole (the way humans visualize terrain). In choosing the location of new construction, for instance, beavers move out from the lodge to the farthest navigable point, and then, once water levels are raised, to points successively more remote, as if they perceived terrain as a set of concentric circles of safe, deep water around the lodge. Thus by a process of successive improvements—by repairing and raising old dams, and occasionally expanding the circumference of the system by making new dams—an increasingly effective control system and a larger safe-water area are developed without the need to locate critical control points in advance.

The principal objection to this theory is the commonly repeated statement that beavers labor most industriously on their lodges and dams, particularly on new construction, during the fall. Rarely is mention made of any burst of activity in the early spring. Richard, however, although he reports that his beavers commence their new constructions no earlier than June and that the urge to repair remains constant throughout the year, does note parenthetically that there is a "renewal of construction during gestation." Morgan himself states emphatically that new construction is preferably undertaken in September and October and more generally that "the active season for beaver work is late in the fall—performed with reference to the approaching winter, of which they are not unmindful." But specifically on the subject of repair, he is cautious, merely remarking that it is difficult to observe and that "repairs are made, whenever they seem to be required, by each beaver acting independently." These observers, however, seem to be primarily interested in new constructions rather than repair and maintenance in long-established wild colonies. Much of the remaining literature on the beaver is anecdotal, or directed to other questions, and does not contribute to the solution of the problem. Our own experience suggests that careful observation of wild beavers may show



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Side Pool Dams

Beavers wasted effort in stopping leakage from their creek to adjacent canal. Instead of building one dam at the trouble spot, they constructed this series of dams nearby. Below, canal maintenance personnel subsequently placed plank across breach.

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that repair work and raising dam height (which is the essential activity for an established colony) is concentrated in the spring in most colonies, but has been less than regularly reported because of difficulties of observation. Early spring is apt to be the most difficult time to observe, since vehicular or boat travel is awkward and on foot the observer is inconvenienced by cold, wet ground, slush and snow, and flooded streams and ponds. Thus the new construction and repair work that does occur in summer and fall, even though less intense an activity than in spring, is far more likely to be observed.

The objection may also be raised that our interpretation is unnecessarily reductionistic, leaving little opportunity for the consideration of learning and planning in beaver behavior. With respect to the timing of activity levels and the location of major construction features, we feel that our assessment is fair. It is simplest to account for these strategic choices by neurophysiological processes that involve genetically patterned responses to stimuli. This does not, of course, exclude either the learned improvement of "skill" by imitation and practice, nor "rational" choice within very limited contexts, such as picking the best spot to deposit a stick or building up a learned map of the territory. But the vagaries of location of lodges and dams, as well as the often wasteful duplication of effort in one spot, while another, more crucial from an engineering standpoint, is ignored, do not suggest a rational approach to the problem.

Still, a relatively large domain of behavior is left open to culturalistic explanations. Although it does not appear that either learning or culture are factors in the broader strategy of construction work, they may and probably do have a bearing on instrumental skills. These skills are employed in choosing, cutting, carrying, and placing wood and other materials on the construction site, and in trimming and repairing dams, lodges, and canals. Although we do not possess sufficient data to prove the assertion, we feel that young beavers learn by following and imitating their parents, and as adults by trial and error, and thus pass on from generation to generation in any one colony what might be called a local tradition or style of work.

There appear to be differences between colonies that would be hard to explain otherwise. For instance, some colonies trim the jagged edges of the sticks that form the face of the dam in order to make them level with the top surface; others leave a rough palisade. Some colonies (Morgan observed this type in Michigan) construct solid dams with spillways; others use a looser construction and allow water to percolate through. The Penn's Creek beavers are somewhat sloppy in dam construction compared with others Mrs. Lathbury observed in Virginia. It would be desirable in further study to determine whether these variations are merely the result of differences in the local topography and construction materials available or whether they reflect local cultural differences. Would beavers livetrapped and transplanted to a new area continue to build in the same fashion as in their former habitat or would they conform to the style of the new locale? Would infant and adult beavers so transplanted differ? Such natural experiments would help to unravel the mystery of beaver cultural capacities.

SKY REPORTER

LUMPS UNDER LUNAR SEAS While Lunar Orbiter V was circling the moon on a picture-taking mission a year ago, tracking stations on the earth kept a careful eye on the spacecraft. Painstaking analysis of the Orbiter's flight has paid off. Distinct spurts of one mile per hour (while the Orbiter flashed along at 4,500 mph) have revealed massive lumps of dense material beneath the lunar surface.

Orbiter V accelerated each time it passed over one of the ringed seas on the moon's near side. Scientists at the Jet Propulsion Laboratory in Pasadena, California, have computed that the accelerations could be caused by a spherical chunk of nickel and iron about 60 miles in diameter—the size of a small asteroid.

Paul M. Muller and William L. Sjogren reported these findings in the journal *Science*. They point out that their discovery raises further questions:

Does each of these mascons (mass concentrations) represent an asteroidal-sized body that caused its associated mare (sea) by impact? If the mascons are not simply the original impactors themselves, by what processes were they formed in the lunar interior? Is the presence of these objects consistent with a molten lunar interior?

The authors say the presence of large mascons under every ringed mare (and their relative absence elsewhere) suggests a relationship between the two phenomena that may be similar to that proposed by Harold C. Urey and the late G. K. Gilbert. In essence, this theory proposes that the energy dissipated in the impact of an asteroid on the moon could have resulted in intense heat, causing surface lava flows and the formation of very dense concentrations of matter.

SIZING UP NEPTUNE Neptune is nearly 3 billion miles from the sun; we have few facts about it, and even those tend to be less than exact. Last April, while this slightly greenish major planet was retrograding through Libra, it chanced to occult a star and reveal something of itself in the process.

Although Neptune's mass had been calculated from its effect on other planets, its diameter was uncertain by nearly 5,000 miles. (Its speed across the sky, however, was known—about three seconds of arc per hour.) So on April 7 astronomers in Japan, Australia, and New Zealand were ready: They timed the disappearance of the star behind Neptune, and its reappearance about 40 minutes later.

Gordon E. Taylor of the Royal Greenwich Observatory reported the results in the British journal *Nature*. The new diameter was calculated to be 31,250 miles. Now that scientists know both the mass and size of Neptune, they are better able to determine the planet's density, thus allowing more accurate speculation about its composition and history.

SLOW CARTOGRAPHY Scientists at the Jet Propulsion Laboratory are laboriously putting together a map of Venus by bouncing radar signals off our sister planet. The job requires patience. They can only work when Venus comes close to the earth, and even then they have only a barely detectable echo to use.

Richard M. Goldstein and Shalhav Zohar have been concentrating on an area of the planet's northern hemisphere in which three features stand out in radar scanning. Their "map" to date is only a blotch, but the two men report in *Nature* that they are beginning to detect detail within one of the features, known as Beta. They believe the 150-mile, roughly circular region may be mountainous, but concede that the strong radar reflectivity could also be caused by craters or extensive fields of boulders.

A similar region, called Delta, lies 600 miles north of Beta, and a third area, as yet unnamed, has been found to the northwest. Still other areas of high reflectivity have been discerned in other parts of Venus, according to Goldstein and Zohar.

When Venus comes close enough (26 million miles) for radar study again next April, the radar astronomers will have boosted their transmitting power from 100,000 to 450,000 watts, and hope to achieve the most detail since Beta was first detected in 1962. Such radar observations promise to give us the only view of our cloud-shrouded neighbor in the foreseeable future.

THE PULSAR SCORE Pulsars are being found right and left. Anthony Hewish's team at Cambridge, which found the first four, announced the discovery of two more. And the first two in the southern sky were discovered by the Molonglo Radio Observatory in Australia.

Both of the southern pulsars are interesting. One has the longest period of any yet discovered, 1.96 seconds. And the other lies in the direction of the galactic center. Its discoverers, A. J. Turtle and A. E. Vaughan, said, in their report to *Nature*, that it should be possible to establish unambiguously that this one is within the Galaxy.

Another pulsar was announced by two scientists, Harold D. Craft, Jr., and Richard V. Lovelace, at Cornell University's Arecibo Observatory in Puerto Rico. No one seems to doubt that more will be found. What they are is another question.

BUDGET SPACE PROBES A special committee of the National Academy of Sciences has urged NASA, already faced with its smallest budget in years, to spend more of its money for unmanned planetary exploration. The space scientists specifically recommended that Pioneer and IMP class spacecraft—far cheaper than the Mariners—be sent to Mars and Venus at each opposition between now and 1975. NASA was also urged to swing a probe past Venus to Mercury in 1971, 1973, or 1975, and to make a "grand tour" of Jupiter, Saturn, Uranus, and Neptune in 1977-78—the last time in this century that those planets will be lined up in such a way that a probe can be propelled from one to the next by gravitation.

JOHN P. WILEY, JR.

CELESTIAL EVENTS

The waxing gibbous moon appears in the evening sky of early November and becomes full on the 4th. Thereafter, the moon is in the morning sky until the 20th, when it returns to the evening sky again. Last-quarter is on the 13th; new moon on the 20th; and first-quarter on the 26th.

Venus and Saturn are evening stars. Venus, though brightening and appearing higher each evening, sets shortly after dark; Saturn appears high in the east at dusk and sets before dawn.

November 2-3: Saturn is to the left of the moon on the evening of the 2nd, to the right on the night of the 3rd.

November 4: The full moon tonight is the hunter's moon.

November 5: The nearly full moon will interfere with observations of the Taurid meteor shower, reaching maximum today.

November 6: Jupiter and Mars, rising in the eastern sky before dawn, are in conjunction. Mars now moves to the left (east) of the brighter Jupiter.

November 16: The Leonid meteor shower reaches maximum, with no moonlight to interfere with after-midnight observations. These are fast, bright meteors, reaching a normal rate of about 25 per hour.

The moon rises near Jupiter this morning, followed by the rising of Mars. Before dawn, the moon moves slowly away from the brighter Jupiter toward Mars.

November 17-18: The bright star Spica is to the left of the crescent moon in the morning sky of the 17th, to the right of the moon on the morning of the 18th.

November 22: Venus is close to the crescent moon, to the right and above, in the western sky this evening.

November 29-30: The moon and Saturn are close again this month. Saturn is to the east (left) of the moon on the evening of the 29th, to the west (right) on the 30th.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on November 1; 8:20 P.M. on the 15th; 7:21 P.M. on the 30th; but it may be used for about an hour before and after those times.

The Story of Fireflies *Continued from page 42*

In any given locality, the males and females are highly attuned to one another's messages: that is, the variation in responsiveness is such that they almost never answer another species. Females occasionally reply once to a flash of inappropriate length, but they do not continue to do so. On the other hand, if one compares the flash signals of species that do not occur together he often finds them to be very similar: here there is no possibility of mistakes being made, and refined "isolating mechanisms" have not evolved. It goes without saying that the integrity of species must be maintained, for interspecies hybrids are generally sterile (like the mule) or at least less well adapted for a specific role in nature.

One would assume that the larger fireflies of the genus *Photuris* (studied by Barber) always "speak a different language" from the small fireflies of the genus *Photinus*, (studied by Lloyd). This is generally so, but there are some fascinating exceptions. H. S. Barber commented as follows:

"Sometimes the familiar flashes of a small species of Photinus male are observed excitedly courting a female, supposedly of the same species, whose flashes appear normal to its kind, but when the electric light is thrown upon them one is startled to find the intended bride of the Photinus is a large and very alert [and predatory] female Photuris facing him with great interest. Does she lure him to serve her as her repast? Very often a dim steady light near the ground proves under the flashlamp to be a small, recently killed Photinus being devoured by a nonluminous female Photuris. . . ."

James Lloyd, while working on *Photinus*, found it possible to obtain females of a given species by walking about in a suitable habitat, imitating the flashes of the males with a flashlight. Now and then, however, the females that signaled back to him turned out to be, not *Photinus* females, but those of the genus *Photuris*, responding appropriately to specific signals of a certain species of *Photinus*! Once he watched one of the *Photuris* females for half an hour and saw her respond to twelve passing *Photinus* males, in each case after the interval characteristic of that species of *Photinus*. All of these males were at least partially attracted to her. Finally, a male landed near her, and after an exchange of signals ceased to light up after the usual time period. Lloyd checked and found that the *Photuris* female was clasping the *Photinus* male and chewing on him.

It might be added parenthetically that insects are known that utilize luminescence, not for courtship, but strictly for luring and then feeding upon various small insects that are naturally attracted to light. Both in North America and in Europe there are certain gnat larvae that spin silken webs close to the ground and emit a dim, bluish light that probably serves to attract tiny midges and other insects into the web. An even better example is provided by the so-called New Zealand glowworm, which is not a true glowworm at all but another gnat larva. These insects live in certain caves in New Zealand and are so spectacular that guided tours are conducted into some of the caves. The gnats lay their eggs in a gluelike substance on the ceiling, and the larvae suspend themselves from silken sheaths and emit a bluish-green light that is said to lure small insects into the tangle of webs, where they are consumed by the larvae.

True fireflies are capable of remarkable displays at times. Occasionally, especially in the tropics, untold thousands of fireflies will gather

in a single tree or several neighboring trees and flash for many hours, sometimes for many nights in succession, producing a glow that can be seen half a mile or more away. Sometimes all the fireflies in a tree have been seen to flash in synchrony. Such displays have been reported from Southeast Asia and the East Indies for over two hundred years—but hardly ever from other parts of the world. Hugh M. Smith, while studying the fisheries of Thailand in the 1930's, often took parties of visitors down the Chao Phraya River near Bangkok to observe the displays. In an article in *Science*, he described them in these words:

"Imagine a tree thirty-five to forty feet high thickly covered with small ovate leaves, apparently with a firefly on every leaf and all the fireflies flashing in perfect unison at the rate of about three times in two seconds, the tree being in complete darkness between the flashes. . . . Imagine a tenth of a mile of river front with an unbroken line of [mangrove] trees with fireflies on every leaf flashing in unison. . . . Then, if one's imagination is sufficiently vivid, he may form some conception of this amazing spectacle."

Smith went on to say that the synchronous flashing occurs "hour after hour, night after night, for weeks or even months. . . ." Reports such as Smith's have tended to remove much of the skepticism that greeted earlier accounts. For years the explanation of this unique phenomenon has intrigued John Buck, of the National Institutes of Health at Bethesda, Maryland, one of our leading authorities on fireflies. Some time ago he found that he could induce synchronous flashing on a small scale in the American firefly *Photinus pyralis* by using a flashlight at the usual interval of females of this species. When there were many males about, he could sometimes attract fifteen or twenty of them at once, and these would all adjust their flash periodicity in accordance with that of the female. "It is indeed an impressive sight," says Buck, "to see such a group converging through the air toward one point, each member poising, flashing and surging forward in short advances, all in the most perfect synchronism." It seemed possible that small groups such as this might build up within a larger aggregation, and so stimulate one

another that all fell into synchrony.

In another experiment, Dr. Buck placed a large number of males of this same species in a large, dimly lighted cage, where they soon began to flash in their usual manner. He then subjected the fireflies to sudden and complete darkness, whereupon all of them flashed at once, then again after four or five seconds. The synchrony persisted for some time and then disappeared. Buck felt that the unnatural advent of sudden, total darkness was not important in itself, but only because it served to increase the relative intensity of the flashes of neighboring fireflies, causing them to respond to one another's flashes as they would not do ordinarily.

But of course these simple experiments performed on a North American species merely whetted his appetite for the real thing, and a couple of years ago John and Elisabeth Buck took off for Thailand and Borneo. They were successful in finding "firefly trees," and they made photographic and photometric analyses that indicate that the synchrony of great numbers of individuals is indeed nearly perfect. They found that (contrary to earlier reports) both males and females occur in these trees, although the females do not participate in synchronous flashing. They showed that mating occurs in these trees, suggesting that the brilliant, synchronous flashes serve as a beacon to attract females from the surrounding forest. This may explain why this phenomenon is most prevalent along rivers in the Far East, for in this part of the world the exceedingly dense, tangled swamps would hardly be conducive to individual flash communication similar to that occurring in a New England meadow. A firefly tree along a watercourse, however, would provide an assembly beacon of ready access. Not only would the synchrony of the flashes increase the brightness, but the alternation of light and dark would also be eye catching, like the flashing neon signs that are a recent invention of man—though I think man has overdone a good thing, as he so often does.

The Bucks consider synchronous flashing to be a complex of behavioral patterns (congregation, selection of certain trees, flashing, synchrony, and so forth) that have evolved together into a spectacular device for enhancing mating under

otherwise difficult conditions. Evidently, newly emerged males and females are constantly recruited from the surrounding forests, for individuals do not live more than a few days, and there must be a constant turnover in the population. The Bucks showed that males released in a darkroom are attracted to each other's light, and this suggests that wandering individuals might readily join a flashing swarm. It remains to be proved that there is a traffic of freshly emerged males and females into the trees and of mated females away from them. And it remains to be shown how the males maintain almost perfect synchrony from one end of a large aggregation to the other, when, in fact, laboratory studies suggest that the males react to one another over only short distances and that their reaction time is considerably greater than the variation in synchrony observed in nature. There is evidence that near-perfect synchrony occurs only in very dense aggregations, while in diffuse gatherings the flashing may be random. In some instances more than one species may aggregate in a given tree, resulting in a complex combination of flashes that is still presumably effective in attracting females of the species involved. All these are matters requiring much further study.

But of course scientists are used to partial and provisional answers: it is their stock in trade, and half the fun of science. H. S. Barber was well aware that his field studies of *Photuris* were only preliminary. And after a lengthy review of laboratory studies, John Buck concluded:

"In spite of the many morphological and physiological data which concern luminescence in the firefly, there seem to be surprisingly few unequivocal major conclusions which can be drawn."

This is "par for the course." Such is the complexity of living systems that tens of thousands of research workers all over the world each year push our knowledge forward by only a minuscule amount, with now and then a breakthrough that opens up a new area of ignorance. A century from now our great-grandchildren may marvel at how little we knew about fireflies. At least I hope so. In the meantime we may be unashamedly romantic or unflinchingly rigorous toward fireflies, as befits our nature, and still know their magic.

 Continued from page 56

up into the Sierra Nevada range—somewhat difficult to drive during summer months and completely blocked with snow during the winter. Potential developers were not interested in building a ski resort that no one could get to. No sizable recreation complex could be installed without widening and straightening the roadway.

In addition, the road winds across eleven miles of Sequoia National Park before dead-ending within Sequoia National Forest at the small cluster of summer cabins and public campsites that make up Mineral King village. Thus, developers may have been intimidated by the legal and political complications of interfering with a road crossing land controlled by the National Park Service.

At the time the 1965 prospectus was issued, no solution to the access problem had been found: but in the 16 years that had elapsed since the first prospectus, knowledge had spread of the Forest Service's interest in the area. Learning of the intentions to develop the area's ski potential, ski clubs, developers, businessmen, and politicians in Tulare County (where Mineral King is located) began to regard the resort, along with its access road, as a real and desirable possibility. One hopeful developer (Walt Disney Productions) had speculatively purchased a small amount of private land in Mineral King Valley. Furthermore, the rapid increase in the number of California skiers had expanded the undertaking's potential support. Thus, in issuing the 1965 proposal, the Forest Service had some cause for believing that public and political support could be mustered for both the project and its necessary road.

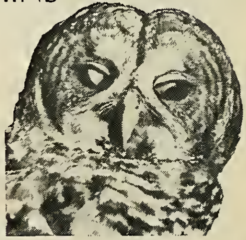
The optimism was well founded. During the summer of 1965, the California state legislature voted to add a new highway to the state's road system. Highway 276, from the town of Hammond to Mineral King, would replace the old access road, would be kept snow-free by the state (the old access road was county maintained), and would ostensibly be wide enough to accommodate sufficient traffic at the proposed resort. The road is planned as a relatively straight, two- to three-lane highway, capable of handling about 1,200 automobiles per hour at speeds of about 50 mph. In addition, six bids were submitted to the Department of Agriculture for construction and operation of the recreation complex. These were narrowed to two, and finally, late in the year, a winning bid was announced. In December, Walt Disney Productions was chosen to carry out the Mineral King development and was awarded a 3-year permit to perform its initial studies of the region.

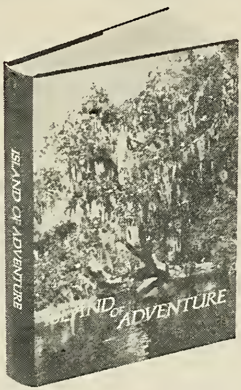
Up to this point, little opposition had been expressed to the project, except by local groups of outdoorsmen and by cabin owners in the Mineral King area who would be displaced by the development. National organizations that might normally oppose the area's commercial development were preoccupied with the problems of dam building in the Grand Canyon, cutting of redwoods (in the proposed Redwoods National Park), and other well-known issues. Some feared that opposition to the Mineral King ski resort would only serve to increase pressure by skiers to develop the San Gorgonio wilderness and were therefore reluctant to take a stand. Others, thinking outright opposition too late, felt that the best strategy was to try to limit the project's size. A few were even unsure of Mineral King's whereabouts, let alone its significance. But when the magnitude of the Disney development proposal was disclosed, the traditional champions of the natural environment—the Sierra Club, Wilderness Society, and National Parks Association—quickly realized that they were confronted with another major battle.

The Forest Service's original guidelines for the recreation complex were relatively modest: three or four ski lifts, parking for 1,200 automobiles, and resort accommodations for 100 overnight visitors—tempered by the warning that all facilities would have to remain "compatible with the aesthetic values of the area." The Disney firm, however, is known for doing things in a big way, and Mineral King is no exception. The original Disney plans called for a $35 million investment to include an alpine village, a heliport, a golf course, a reservoir-skating pond, swimming pools, an auto service station, two hotels, a 500-room dormitory, 1,200

cabins, a 20-acre parking lot for 2,500 autos, and ten restaurants within Mineral King Valley and on surrounding mountain peaks. In summer general sightseeing would be the main attraction; in winter skiing would bring as many as 20,000 visitors into the valley each day, from whence they would be whisked into the high country of the Sierra Nevada wilderness aboard 20 overhead lifts, which would radiate from the valley. Some of the lifts' towers would go beyond the boundary of Forest Service land and would be anchored in adjoining Sequoia National Park. Supplemental plans revealed the firm's interest in a facility, located well within Sequoia Park's Hockett wilderness area, that could accommodate cross-country skiers. Walt Disney Productions expects an annual income of about $23 million from the resort during the first years of operation, with this sum increasing thereafter as the area's popularity grows. The Disney plans also noted that "Mineral King's great natural beauty must be preserved at all costs."

With the plans before them, opponents of the development felt pressed by a twofold threat. First, they feared the immediate damage to the alpine environment that would result from construction of a roadway and a resort, and from the heavy human traffic. The prospect of bringing 2.5 million visitors annually into the heart of the mountain country conjures up pictures of tourists picking the ground clean of unusual rock fragments, wildflowers, evergreen cones, and other portions of the alpine landscape; of skiers watching the white wrappers of their candy bars slowly floating to the ground after being tossed from the gondola of one of the aerial tramways: of erosion caused by construction activity; sewage pollution in the Kaweah River; and of the intrusion of automobiles, buildings, and large numbers of visitors upon the mountain landscape. In addition, project opponents object to the disregard by the Forest Service and Walt Disney Productions for Mineral King's current status as a national game refuge. Among naturalists aware of the development plan a favorite parlor game during the past few months has been the casting of Smokey, the Forest Service bear, and Disney's Mickey Mouse in Simon Legree roles





—dispossessing their fellow creatures in order to build the Mineral King resort ("Smokey strikes again!").

The Forest Service is well aware of the potential danger to the Sierran landscape posed by the planned resort. They note that "Mineral King can 'stand' development to only a certain level," but also contend that "Walt Disney Productions does not plan, and the Forest Service would not permit, a development beyond that capacity threshold." But "capacity threshold" lends itself to subjective interpretation, and what the term means to the Forest Service is apparently quite different from the meaning given by most of those opposed to the project. To the former group, it probably means a general attempt to keep ecological damage to a minimum, whatever the level of construction and human visitation. The latter define the phrase in terms of wilderness, in which case the threshold will likely be exceeded on the resort's first day of operation.

In a way, these differences of opinion reflect the essential conflict between the protectionist groups such as the Sierra Club and those more inclined toward development. Both are aware of the perplexing problem of providing recreational opportunities for a population that doubles every forty years, while our static land supply stubbornly refuses to expand despite the demands placed upon it. However, their approaches to this situation are quite different. The development faction seems to feel that the way to alleviate this difficulty is to make increasing portions of the environment easily accessible to the current demands of the population so as to spread the "visitor impact" over a larger land area. (Walt Disney Productions, for instance, notes that "the value of much public land . . . is lost because the land is inaccessible.") On the other hand, the protectionists view the growing number of claims upon the land as reason to stiffen its protection, perhaps to the point of rationing its use. This "pinch," they hope, will forcefully focus the attention of hunters, highway engineers, wilderness lovers, and resort builders on the real source of the growing real estate shortage, and will elicit stronger public sentiment to deal with the problem before the remaining public land is consumed.

From the viewpoint of the Sierra Club and its allies, the greatest threat posed by the Disney recreation complex and its access road is the influence these developments would exert upon the future protection of wild lands of the southern Sierra Nevada surrounding Mineral King Valley. Most of this land—in both Sequoia National Forest and Sequoia National Park—meets the criteria for "formal" wilderness status as defined by the 1964 Wilderness Act, and is now being considered for legal protection according to the provisions of that act. However, the presence of a high-grade highway bringing millions of people into the heart of the region would probably diminish its wild character in short order, obviate the inclusion of this land within the wilderness system, and encourage less rigid protection of adjoining land. In addition, there is some fear that the presence of a high-standard road reaching halfway across the Sierra Nevada range will be used as a rationalization for extending the pavement another 30 miles to create a new trans-Sierra highway through one of the country's last enclaves of primitive landscape.

In a way, it is tempting to apply the philosophy of "conservation democracy," advocated by Gifford Pinchot and Theodore Roosevelt, to the Mineral King situation: "the purpose of Conservation is the greatest good of the greatest number for the longest time." This concept invariably underlies the arguments in nine out of ten land-use conflicts, but despite its seeming simplicity, it poses questions that cannot be readily answered. Who can say, for instance, whether a ski resort, a semideveloped campsite, or a primitive landscape will be of greatest benefit to people who have not yet been born?

Nevertheless, the concept stimulates some interesting speculations about the future. In the case of Mineral King, you might ask what needs will characterize Californians in 2068: The need for convenience or for diversity? For material comfort or challenge? For sociality or solitude? Which need will be most in demand and least in supply?

Even at present, there seems to be a considerable difference of opinion over the proper application of these democratic guidelines. Both the Forest Service and Walt Disney Productions maintain that a new high-standard roadway into the Mineral King country will represent an im-

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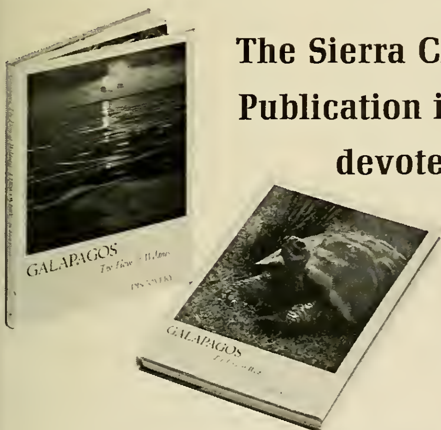

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provement over the current situation because it will permit the rapid influx of large numbers of visitors ("Many people wish to see and enjoy Mineral King but won't drive the present difficult road."). To this argument however, their opponents reply that the area's present function of providing general recreation is inherently more democratic, for it does not impose an admission fee upon visitors. They further contend that in terms of meeting California's most urgent recreational needs, the $35 million to be spent on the Mineral King project might be put to better use by expanding the recreational facilities available to the non-mobile population in, say, the Watts ghetto of Los Angeles.

Throughout 1966 and into early 1967, the Mineral King issue continued to be fought at a local level. In that time, proponents of the Disney project succeeded in gaining political support for the venture. In September of 1966, Walt Disney and California's governor, Edmund G. (Pat) Brown, flew into Mineral King by helicopter to survey the area. Thereafter, Brown made a short speech in which he described the proposed development in glowing terms: "I hope that ten years from today I can stand here with Walt Disney again and look around at the wonderland that will have been created," and assured his audience that "we are going ahead with the [access] road." The Brown administration applied for and received a $3 million federal grant to partially finance the road's construction; the California Highway Commission then voted to provide the remainder of the needed construction money (about $20 million) from the state's highway tax fund.

These actions did not pass unchallenged. California's State Highway Engineer, J. C. Womack, attacked the financing of the Mineral King road stating that the highway could proceed only "at the expense of other critical [road building] projects," and that the use of funds set aside for other construction would prove "very disruptive to previously approved planning and scheduling of projects in the Southern Counties group." State Assemblyman Alan Sieroty assailed the proposed destruction of natural landscape, stating that the plans for the Mineral King road were "atrocious," then added: "It would be . . . outrageous for the Reagan administration [Reagan was elected in 1966] to give away more than $20 million to facilitate a private venture when it has just cut the state Parks and Recreation budget . . . from $33 million to $1 million." In addition to this objection, two bills were introduced into the California state legislature in an attempt to block construction of the access road. Both died in committee before being brought to a vote.

By early 1967, although funding had been approved for the access road and its proposed routing established, and although newspapers in Tulare County were speaking as if the Disney resort was already a fact, the National Park Service had not yet granted permission for the road to cross eleven miles of Sequoia National Park on its way to Mineral King Valley. It is still unclear whether the Department of the Interior can legally grant permission for a road to cross a national park for non-park purposes, or whether this requires an act of Congress.

In any event, Secretary of the Interior Stewart Udall disapproved of the new road. He noted that it would prove a "blighting influence" upon Sequoia Park, that blasting of rock and planned removal of eight million cubic yards of soil would scar park terrain, cause erosion and consequent siltation of the Kaweah River, pollute the air with auto exhaust fumes, pose a threat to giant sequoias and other large evergreens, and would, in general, compromise "park values." With a first-hand sensitivity to the proliferation of the nation's vast network of highways, (3.6 million miles worth) he commented that developers "will be more honored 25 years from now for the roads they do not build than for the roads they do," and suggested that the Forest Service and Disney Productions explore other means (such as an overhead monorail or tramway) of transporting sightseers and skiers into Mineral King Valley to minimize destruction to the landscape.

To answer charges of road damage, the California Division of Highways commissioned biologist Richard J. Hartesveldt, an authority on giant sequoias, to study the ecology of sequoia groves surrounding the proposed roadway. The report's objectivity, however, has provided at least as much ammunition for opponents of the project as for its advocates,

and each side has quoted and paraphrased the document upon numerous occasions.

As for Udall's proposal that a monorail or tramway be used to transport visitors into the resort, this plan was rejected by both Disney Productions and the Forest Service as being too expensive. The cost of installing such a system—unlike the tax-financed roadway—would be borne by the Disney firm.

By mid-year 1967, opponents of the development had finally managed to air some of their grievances to a national audience by means of articles printed in magazines published by the National Parks Association and the Sierra Club. Within these groups, the general feeling seems to be that the only way to provide Mineral King with adequate protection against commercial development is to make it a part of adjoining Sequoia National Park. In 1926, when Congress was wrestling with the problem of what to do with this area, the decision was made to award it to the Department of Agriculture in the belief that there were minerals remaining in and around Mineral King Valley that would become "locked up" if park status were granted. But since no mineral deposits have been discovered, there is a strong feeling now that these 15,000 acres should be given to the Department of the Interior.

This type of interdepartmental land transfer is invariably an unpopular procedure on the part of the donor agency, and is avoided by Congress whenever possible. Just now, the Forest Service is especially sensitive on this count for portions of forestland are being transferred from the Forest Service to the Park Service in order to establish a Redwoods Park in California and a Cascade Mountain Park in Washington. The history of transactions of this sort carries all the flavor of a range war between sheepherders and cattlemen, and while reading these accounts, it is easy to lose sight of the fact that the ownership of federal property rests with the public rather than with the managing agency.

By this time, Secretary Udall was finding it increasingly difficult to maintain his opposition to the access road upon which the success or failure of the development depends. A hint of behind-the-scenes pressure appeared when the Secretary indi-

cated that he would need a great deal more support from leaders of the protectionist movement than they had given him. In addition, the open opposition to Udall's position had assumed formidable proportions. California's two senators, several representatives, lieutenant governor, many state legislators, and Los Angeles Mayor Yorty now stood solidly behind the Disney plans. Senator Thomas Kuchel, who can usually be counted on to champion the position of the Wilderness Society and the Sierra Club, reversed his role in the case of Mineral King and went so far as to write an article in a ski magazine praising the merits of the Disney firm and its proposed undertaking. Real estate speculators and businessmen in Tulare County, anxious to capitalize upon the anticipated influx of tourist gold, were beginning to make impatient noises. These were echoed by Tulare County politicians and newspaper columnists, and by Secretary of Agriculture Orville Freeman, all of whom viewed Udall's reluctance to approve the access road as an obstructionist tactic.

To add more fuel to the fire, Governor Reagan sent emissaries to persuade Secretary Udall to change his stand. Although Udall remained adamant, he was misquoted by a Reagan aide as having given his approval to the Disney project. The story that Udall had conceded, followed quickly by his denial, served only to heighten tension and to increase pressure for a decision.

Of the obstacles faced by Stewart Udall and his supporters, one of the most formidable is the intangible something which Walt Disney Productions calls the "Disney Image." For after being honored by a number of nature-oriented organizations, ranging from the National Audubon Society to the National Wildlife Federation; after thirty years of producing such films as *Bambi*, *Beaver Valley*, and *Nature's Half Acre*, it hardly seems possible that the Disney firm would consent to undertake a project that would in any way prove detrimental to the great out-of-doors. The common conception of the Disney orientation toward the natural world, as the Disney publicity states, is one of a "proven interest in conservation." As noted in the organization's proposal for the development of Mineral King, issued to the Forest Service: "The integrity and quality

nage of Walt Disney Productions is *ready* pre-sold in the public mind." his seems to be the case, particurly in California, where considerble fame and fortune have come to st since the establishment of the isney empire in that state.

In July, 1967, the nature of the ispected pressure on Secretary dall was made public. To the conernation of those who had labored defeat the Mineral King proposal, was revealed that through the comicated machinery of Washington plomacy, the fate of Mineral King ad become linked to the ongoing egotiations between various federal gencies and the state of California er the size and location of the proosed Redwoods National Park. Aprently, the Johnson administration lt that Governor Reagan would be ore amenable to the installation of national park in his state if he were ffered certain concessions in return. ne of several concessions offered e state was the administration's tive support of the Mineral King evelopment and its access road. The ature of this transaction was spelled ut in a letter of June 22, 1967, from administration spokesman, Phillip Hughes, Deputy Director, Bureau the Budget, Executive Office of the resident:

> Following is the Administration position on a number of items over and above the provisions of S. 1370 [the redwoods bill introduced by Thomas Kuchel]. . . . The Administration is prepared to implement these provisions immediately. . . .

he Mineral King proposal is listed nder a section labeled "Other Conrvation Program Actions."

> 6. *Mineral King*
>
> It is in the interest of the Administration and the State that the Mineral King area . . . be . . . developed. . . .
>
> The Department of the Interior has been requested to consider issuance of a permit jointly to the Deparment of Agriculture and the State of California for a two-lane road through the Park [Sequoia] to provide access to Mineral King. . . .

The letter's contents provoked a olley of angry protests from the oject's opponents. Senator Lee etcalf (Montana) assailed the adinistration's intention to "override e Secretary's [Udall's] best judgeent" as raising "fundamental quesons of public policy, precedent and

equity." Anthony Wayne Smith, General Counsel and President of the National Parks Association stated that the Forest Service had "put to auction a priceless asset [Mineral King] belonging to the American people. . . ." California Congressman Phillip Burton perhaps best summarized sentiment against the maneuver when he angrily labeled the Mineral King-Redwoods Park trade as "a desperate effort to pay the high political price needed to get along with California's new governor" and bemoaned the fact that the executive branch "promises to pressure the National Park Service into compromising the integrity of Sequoia National Park by accommodating the opening wedge for massive development of Mineral King."

Whatever the processes by which pressure was exerted, Burton's fears were apparently justified and the intent of Hughes' letter carried out. In December, a high-level Mineral King meeting was called. Attendants in favor of the project included: Secretary of Agriculture Freeman, California Senators Kuchel and Murphy, Congressman (and former Olympic decathlon champion) Robert Mathias, and for the administration, Phillip Hughes. Attendants opposed: Stewart Udall. Shortly after the conference, Freeman issued a press release announcing that the right-of-way for a road through Sequoia Park was being prepared by the Interior Department and that the Disney development would proceed as planned.

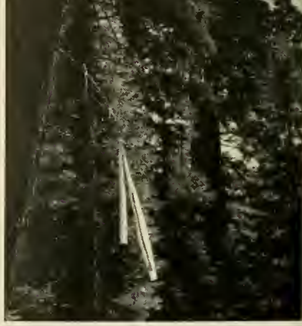
From the point of view of the project's supporters, it probably would have looked better if the release had come from the Department of the Interior with Secretary Udall's blessing. This was not the case, however. To this day, Udall has not voiced support of the access road, leading to the conviction that this decision was predetermined by the administration. Even so, the Secretary was for a time, nobody's favorite. At a press conference in which he was criticized for "his" decision, Udall retorted that things might have been different had preservation groups spent more of their time writing to Orville Freeman than to him.

A surveyor's flag in Sequoia National Park marks the proposed location of the Mineral King access road.

The Mineral King development is now within one step of realization. But this last step has proven time consuming. For in the year that has elapsed since Orville Freeman's announcement, the Forest Service and National Park Service — never the friendliest of "sister agencies"—have failed to reach agreement on the dimensions of the proposed access road crossing Sequoia National Park.

The delay has proven helpful to the more tenacious of the project's opponents; has given them time to begin legal investigations and to renew efforts to gather public support. During the past five months, two to three thousand signatures have been added to an antidevelopment petition circulated by the Sierra Club, network television stations have hauled their cameras into the Sierra Nevada to cover a "hike-in" staged in opposition to the project, and students from UCLA have pulled up and burned survey stakes marking the location of the proposed access road. Some of the more militant even plan to picket Disney films and to stage "lie-ins" in front of highway department bulldozers if construction begins, as scheduled, next summer.

It seems that the era of modern conservation weaponry is upon us. Whether or not this will aid the case for Mineral King will depend on public opinion and on the orientation of the new President-elect toward the issue. Resolution of the conflict will not be long in coming.



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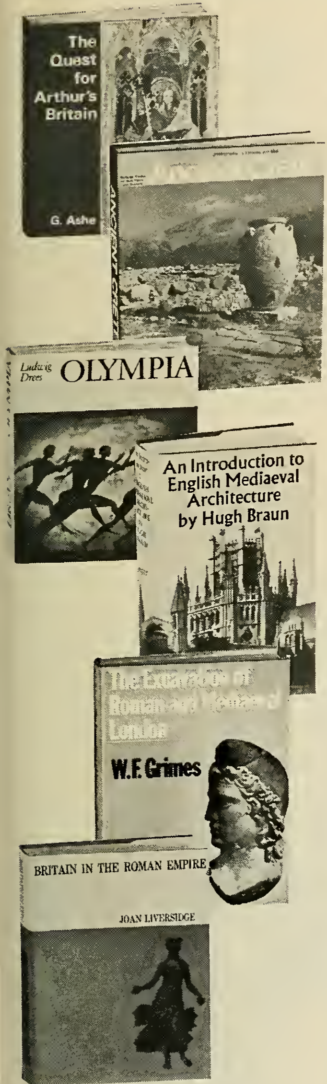

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The Right Way to Walk Four-Legged

Continued from page 39

front. It gives the gait I call the false walk. and is illustrated by the Carneirotherium in color.

This gait is false, in the sense of being deceptive, because it resembles so closely the correct or true walk: it meets completely the requirements in our definition of quadrupedal walking. Like the true walk it, too, keeps at least one front and one hind foot on the ground, and its stride looks very much like that I have shown in the true walk. If a chart of the false walk were drawn in precisely the same way as that of the true walk, and if all phases of both were depicted in pure silhouette, so that we couldn't tell left from right, it would be impossible to distinguish any phase in the true walk from the corresponding phase in the false walk.

In actuality, however, bad triangles and bad support exist as long as this gait continues. A heavy animal would find the resulting loss of balance an intolerable handicap. This is why animals, in general, never use the false walk, although its positions are often used in art.

But not all of the errors perpetuated by artists are found in the false walk. There are also the gaits that I call "thinker's walks." These compounds of fact and fallacy appear to have been derived from two things: the observable truth that a quadruped is like two bipeds joined together. and the less obvious idea that bipeds might wish to step in unison rather than a half step apart.

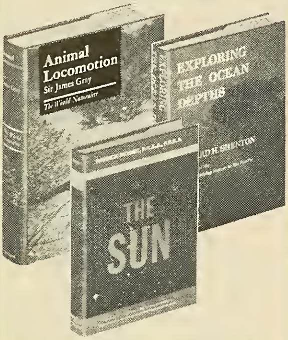
Such kinds of walking are reasonable enough, and unlike the false

"Phony Pony": this is the bronze statuette, supposedly from ancient Greece, that was later branded as a forgery.

walk, animals occasionally perform them. One kind includes the position found in so many Egyptian, Babylonian, and Assyrian animal representations, and less frequently, in Grecian and Far Eastern ones. In this gait, movements of the lateral feet are synchronized. In another thinker's walk it is the diagonal feet that are synchronized, giving the position, beloved both by medieval and more recent artists, that resembles the trot in some phases.

Analysis of both gaits reveals that in most respects both meet the definition of quadrupedal walking, but in two, they do not. Contrary to the true walk, neither thinker's walk has a pattern of 3-foot, 2-foot, 3-foot support, or a pattern of 4-foot, 3-foot, 4-foot, 3-foot support. Instead the support in both is 4-foot, 2-foot, 4-foot, 2-foot. This changes the beat from the even 4-4 time of the true walk to a 2-4 time, which has two feet striking in unison. These are not necessarily disastrous flaws. As in the true walk, speed can vary with small risk of the feet interfering with each other. Also, stateliness and liveliness are found in both of these thinker's walks. Nevertheless, they should be taboo to an artist who purports to portray an animal walking correctly.

Readers who want to look into walking for themselves should realize that some animals almost never walk. When we see them, they are trotting or running if small; others may hop like rabbits or kangaroos—or perform some floppy gait like the walrus. However, in big animals that move slowly on all fours, you may be able to see the succession of footfalls and some of the tripods that are formed. These are the things most easily seen, understood, and remembered. Watch a horse, a cow, or a sheep graze slowly across a pasture, or a cat stalking its prey. Or watch a bird dog at work—whenever his motion becomes frozen, the tripods of support are quickly apparent. I have only one word of warning. There is one class of animals, and as far as I know, only one, that does not use the foot sequence and foot support of the true walk. These are the quadrupeds of the Primate family. Except for their young, they seem to prefer the gait I have termed the false walk. Apparently they have satisfactory reasons for being an exception. Next time you are at the zoo watch the monkeys.



A Four-Letter Word Problem

by Raymond W. Mack

SCIENCE AND THE CONCEPT OF RACE. Edited by Margaret Mead, Theodosius Dobzhansky, Ethel Tobach, and Robert E. Light. *Columbia University Press, $6.50; 177 pp.*

Surely, educated Americans are alert to the foolishness of old-fashioned racism, and are aware of the differences between socially defined races and biologically defined populations. Whether or not they know the technical terminology, educated citizens know that the social categories called races are compounds of individual differences, that the differences are usually relative rather than absolute, and that these "races" ordinarily differ in the frequencies of some genes rather than in their presence or absence. Human beings belong to a single species, and each subcategory of that species, which we call a race, has demonstrated that some of its members are able to learn anything invented by the members of any other race. Eh? But listen.

"Can it be that our humanitarian welfare programs have already selectively emphasized high and irresponsible rates of reproduction to produce a socially relatively unadaptable human strain?" This question was raised in 1966 by an American Nobel laureate at a meeting of the National Academy of Sciences. Perhaps there is still need for a volume such as *Science and the Concept of Race*, addressing an educated audience on a topic about which they remain inadequately educated.

The book grew out of a symposium at the December, 1966, meetings of the American Association for the Advancement of Science sponsored by the Scientists' Institute for Public Information and the Committee on Science in the Promotion of Human Welfare. If, like me, you tend to stop reading when you hit the word "symposium," do make an exception in this case. The editors have brought to book a provocative and well-integrated volume, and one is indeed well educated if he cannot learn several fascinating things from at least one of the three sections on behavior-genetic analyses, biolog cal aspects of race, and social an psychological aspects of race.

Margaret Mead's introduction poin out that the problem is not one sten ming from the knowledge of scientis versus the ignorance of others; on th contrary, generalizations about rac based on inadequate, discredited, an inappropriate evidence are publishe under the names of men who have hel responsible academic positions—W. (George, Carleton Putnam, and Henr E. Garrett. The layman who is not specialist in either biology or soci science, when assaulted with racism b scholars armored in academic creden tials, needs a summary of the evidenc and a straightforward report of th assessment of the data by the best con temporary scientists. This book do not offer a consensus—the contributor are too good for that. It offers th reader the straight dope.

The first paper, by Peter Kilham an Peter H. Klopfer, reports researc demonstrating that organisms are pr grammed with perceptual systems suc that an experience is prerequisite to response, but that the nature of th organism limits both the experience and the responses possible. Naïv chicks, yellow or black, show no co sistent tendency to approach othe chicks of the same variety. Whe reared with chicks of their own variety however, they develop a preference fo their own kind. This experiment dem onstrates elegantly that although piece of information is transmitte genetically, it may nonetheless requi an appropriate environment to man fest itself.

These data are supported in th essay by Benson E. Ginsburg and Wi liam S. Laughlin, who conclude tha there is "a reciprocity or feedback be tween the genetic potential of a popu lation and its social structure, such tha not only does the former determin what the latter can be, but the latte exerts an important biological effect o the former." It is important to unde stand that potential behavorial adapta

tions do not in any way atrophy from disuse. In other words, any genetically diverse population has the potential to replace another in the human species.

In a brilliant essay, Jerry Hirsch argues that the whole heredity-environment debate is a pseudoquestion. Hereditability estimates are offered as answers to a question concerning the ontogeny of a single individual, but the answers are based on test performances of a cross section of a population of individuals at a given point in time.

"In order to understand the meaning of a measured heritability, it is important to understand how it is obtained. It is derived from the measurement of the expression of some trait by a certain set of genotypes in a certain set of environments. Statistical analysis of such measurements (based on very explicit additivity assumptions) then yields an estimate of the percentage of trait variance that is inferred to be related to the *additive* contemporary genetic variance. Such measurement naturally requires a perfectly balanced experimental design—all genotypes (or their trait-relevant components) measured against all environments (or their trait-relevant components). Few, if any, behavioral studies have been so thorough, and certainly not any human studies."

Hirsch's paper leads nicely into the discussion by Herbert G. Birch of what is genetic and what is determined, where Birch stresses that any mode of thought that fails to appreciate the inseparability of gene complex and environment in the development of phenotype is scientifically worthless. He concludes that:

"If the data of behavioral genetics permit us to draw any conclusions with respect to learning ability it is that learning ability is by no means a unitary trait, and that in different organisms different patterns of responsiveness, of motivation, of emotionality, and of antecedent history contribute substantially to determining which subgrouping will learn most effectively under conditions of different instruction and task demand. It appears, therefore, that a sober judgment would lead us to conclude that differences in learning achievements, whether measured by intelligence tests or by school achievement in human beings, represent the products of different degrees of goodness of fit between the learner, the task, and, in particular, the instructional mode."

One of the most fascinating sections of the book is the discussion of these first four papers by J. P. Scott in which, building on the research which has been done on lower animals, he suggests a set of hypotheses for testing in human populations, including: (1) antagonism between like individuals, (2) limited relationship between physical characteristics and behavior, (3) evolution toward adaptation, (4) genetic homeostasis, (5) the importance of emotional and motivational factors in affecting behavioral performance, and (6) lack of direct relationship between gene and behavior. The last is powerfully relevant for studies of racial differences, suggesting that two populations may appear to be behaviorally identical even though they are known to be genetically different, or behaviorally different under slightly different environmental conditions even if genetically identical.

With his usual economy of phrasing, Theodosius Dobzhansky brings us to the intersection of the biological and the sociological problems:

"The inhabitants of different parts of the world are often visibly different, and the differences are in part genetic. This, in a nutshell, is the essence of race as a biological phenomenon. To be sure, any two persons, even brothers and sisters, also differ. Race differences are genetic differences between Mendelian populations, not between persons. And yet races differ in the same

traits in which persons also differ. Difficulties arise because when a race or any other group is given a name, one is likely to asume that the individuals composing the group are alike or at least very similar. This is typological thinking, which befuddles not only the man in the street but some scientists as well. . . . Except for identical twins, everybody is biologically, genetically, different from everybody else. Diversity should not, however, be confused with inequality. Equality and inequality are sociological, and identity and diversity are biological phenomena. Diversity is an observable fact; equality, an ethical precept. Society may grant or withhold equality from its members; it could not make them genetically alike even if this were desirable."

After a brief and rather charming set of personal reflections on the race problem by Loren Eiseley, Bentley Glass delivers the "coup de race" to typological misconceptions by pointing out to his audience that probably no two persons sitting next to each other would differ by fewer than several hundred genes, but that there are not more than a dozen different genes that it would be easy to specify as occurring in one race but not in others.

The second section closes with a thoughtful chapter by Paul T. Baker on the biological concept of race as a research tool, followed by brief discussions by Ernst Mayr and Ethel Tobach.

I am annoyed to have to report that the social science section of the book constitutes a clear step down in quality from the sections on behavior-genetic analyses and on biological aspects of race. I would be embarrassed if these last four chapters represented the best that social science has to contribute to our understanding of race. They do not, so I am merely annoyed. I do hope that other scientists, who would like some idea of what social scientists know about the consequences of the social definition of race, will look at work of the quality, for example, of Robin M. Williams' *Strangers Next Door* and O. D. Duncan and Peter Blau's *American Occupational Structure*.

Dwight J. Ingle devotes himself to a discussion of the fact that we do not know that there are no differences in intelligence by race, which is true. When one addresses the policy implications of this statement, however, I do not see how he can argue that we must wait until we know that potentialities are equal and then try to provide equal environments. As Dobzhansky emphasizes, this flies in the face of what we know from genetics, since equal or unequal potentialities cannot be judged until similar environments are provided. Ingle's best comment is in his closing paragraph: "Knowledge can be misused, but ignorance cannot cure."

Morton H. Fried argues that we should end the pseudoscientific investigation of race. He was unable to get anyone to disagree.

Irwin Katz discusses approaches to the study of population differences in achievement. Some of the assumptions he makes are almost as fascinating as the conclusions he reaches as a result of his assumptions. For example: "Given the relatively high proficiency of white students and their teachers, it is not surprising that as the proportion of whites in a school increased, Negro achievement rose. The apparent impact of desegregation can be illustrated by comparing scores on reading comprehension for northern Negro high school students who never had a white classmate with scores of northern Negroes with similar family backgrounds who attended integrated schools from the early grades. When figures from Table 3.3.2 of the Coleman report are consolidated, it is revealed that Negro ninth graders with the longest experience of integrated schooling had an average score of 48.2. This is about five points below the white norm for the same region, but less than two points below the national norm of 50. In contrast, ninth-grade minority-group children who never had white classmates averaged 43.8. Thus it seems that desegregation reduced the racial achievement gap by almost half."

We are not likely to push forward the frontiers of scientific knowledge by such tactics as using processual verbs (increased, rose, reduced) to interpret static comparative data gathered at one point in time. We might better invest our energies in studies in depth of what other variables differentiate Negroes who attended integrated schools from the early grades from those "with similar family backgrounds" who never had a white classmate.

In the final essay, Gloria A. Marshall discusses race as a folk concept, and concludes that it is a word "the continued use of which will serve only to obfuscate the problems entailed in the study of human variation."

People of every race have at one time or another achieved high place, held sway over their neighbors, and advanced in knowledge beyond what was generally known among other races at the time. The Mayas had a decimal system, but no wheel; the Romans had a wheel, but no concept of zero.

The only way we shall ever know whether equality of human achievement is possible is through providing equality of opportunity. Since we do not have genetic identity among human

beings, we can provide equality of opportunity only by providing a diversified environment, a world of multiple opportunities affording outlets for the varied aptitudes of different-looking, different-feeling, and different-acting people.

Dr. Raymond W. Mack is Professor of Sociology and Director of the newly established Center for Urban Affairs at Northwestern University, Illinois.

The World of the Walrus, by Richard Perry. *Taplinger Publishing Co., $5.95; 162 pp., illus.*

A turnip-shaped one-ton body, a wrinkled face, dense whiskers, and drooping tusks make a walrus one of the most grotesque of all sea mammals. Belching, barking, and bellowing, it is the noisiest in the Arctic. On shore, it inches along like a gargantuan worm—extremely vulnerable to human hunters. In the water, however, it is a skillful although not a rapid swimmer.

Only four centuries ago, walruses were abundant in the seas that surround the Arctic icecap. For millennia, Eskimo and other native people preyed on the herds for meat, hides, and ivory without depleting them. Then came Europeans who slaughtered the animals as they hauled out on beaches in densely massed thousands. The present world population of walruses has been reduced to 125,000. Most (perhaps 90,000) of these inhabit the Bering and Chuckchee seas between Alaska and Siberia; almost all the rest live from western Greenland to Hudson Bay.

The history and natural history of the walrus has been compiled from many sources by this British author of numerous natural history books. He has ably synthesized information on the animal's life from its birth as a 100-150 pound calf, which dislikes the water and is guarded solicitously by its mother and all other adults in the herd, to its death among the ice floes at the age of 20 to 30 years. The killer whale is apparently much overrated as a potential foe, and the polar bear may as often be the victim as the destroyer in its rare attempts to snatch a young walrus out of the vigilant herd.

Man continues to be the major threat to the species' survival. Whites are generally allowed only one animal per hunter annually, but great wastage by Eskimo nearly wipes out the presumed 14 per cent increase. Half of the walruses that are now shot (instead of being harpooned) sink and are not recovered. Many are killed for their ivory tusks alone and the carcasses are left to rot or are thrown into the sea. As the Eskimo population increases, one year of excessive hunting could start

another decline in the walrus population.

Perry analyzes his source material carefully. Despite a few lapses, the book is a fine source of information on an unusual, fascinating, and endangered species. It is well illustrated with thirteen black-and-white photographs and a distribution map. There is a six-page bibliography and an index.

VICTOR H. CAHALANE
Zoologist and Author

SIGNALS IN THE ANIMAL WORLD, by Dietrich Burkhardt, Wolfgang Schleidt, and Helmut Altner. *McGraw-Hill Book Co., $10.00; 150 pp., illus.*

In its intent, this is an admirable book. Some of the most fascinating biological studies of recent years have dealt with animal behavior, and specifically with analyses of the environmental cues, or "signals," that organisms rely upon in order to appraise their surroundings. This book attempts to summarize for the general reader certain of the novel and interesting developments in this field. Over a dozen researchers collaborated in the writing. They are almost all German (the book originally appeared in German), and the work they discuss is to a considerable extent their own.

The text is a compilation of short, self-contained essays grouped under three major headings. Part I deals with "sense organs, nerves, and hormones," and serves as an introduction to the ways and means by which organisms gather and process sensory information. The particular subjects chosen to illustrate this general topic deal with insect vision, infrared reception in pit vipers, acoustic localization of prey by owls, gravity orientation in fish, chemoreception in insects, and others. Brief explanations are also given of neurons, nerve conduction, neurosecretion, and hormones.

Part II concerns "the animal in its environment," and deals with symbiotic interactions, mimicry, navigation, and migration. We are here told about such things as ultraviolet patterns in flowers and their significance to insects, orchids that mimic and attract insects, navigation by echolocation in bats, electric localization by fish, olfactory "memory" and upstream migration by salmon, and

Mantid and electric catfish wait for prey; the owl has seized a mouse. From Signals in the Animal World.

time-compensated compass orientation in migrating birds.

The third and perhaps best part of the book deals with the communicative interaction of animals with others of their own kind, with "animal language." Under this heading we find essays on the visual basis of sexual recognition in butterflies, mating calls in grasshoppers, territorial interactions of fish, communicative function of bioluminescence, dance language of honeybees, and odor language of mammals.

Considering that it is only 150 pages long, the book covers quite a bit of ground. Unfortunately, it does not cover all of it equally well. Several of the more sophisticated topics are poorly explained, and the diagrams, although generally helpful, are often insufficiently labeled. A smaller number of topics, treated in greater depth and in such a way as to give the reader more of a feeling of participation in the exciting processes of experimentation and discovery, would have made a better book. The translation is unaccountably bad. Awkward in some places ("Excitingly, most living things are of two types of nature—of male or female sex"), it is downright misleading in others ("Each visual cell is orientated in a particular direction to catch the polarized light and some are specially tuned to certain other wavelengths"). Regrettably, these are real shortcomings, and the positive features of the book, including the stunning and superbly reproduced color photographs, do not entirely offset them. In its present hard-cover format, the book is an overpriced luxury. As a paperback, it would certainly be worth owning despite its faults, and might well meet with fairly general acceptance.

THOMAS EISNER
Cornell University

ORDEAL OF THE ANIMALS, by Mel Morse. *Prentice-Hall, $5.95; 212 pp.*

A century has passed since the organized animal-protection movement reached these shores from England where it began. The first Society for the Prevention of Cruelty to Animals was chartered in New York State in 1866, followed, in 1868, by societies of similar name and purpose in Massachusetts, Pennsylvania, New Jersey, and California. Within a decade the idea of social justice for animals was firmly established in North America.

Animal-welfare activities have a high visibility, and much has been accomplished in setting legal safeguards and in educating oncoming youth as to man's relation to the natural world. However, Mr. Morse's focus in *Ordeal of the Animals* is not on past achievements, but rather on the continuing vulnerability of the lower animals and

man's genius for exploiting the beast world. One of his most telling points is that cruelty today is seldom seen. In the nineteenth century, when a drayman beat his horse he committed a public act. Today's violations occur privately; for example, on the business premises of dealers sending animals, many of them stolen, on their *via dolorosa* to an experimental laboratory or a nearby high school biology class that will—once again—prove conclusively that cats do not have nine lives.

Much abuse of animal life—such as dog fights or the more than eight thousand cockfights held in 1967, although banned in every state except Florida—is illegal and therefore clandestine. Other blood sports also continue to flourish, including the rodeo, America's own version of the bull baits of medieval England. Mr. Morse characterizes these performances as animal abuse packaged as Americana. He also discusses coon-on-a-log contests and touches profanely the sacred subject of horse racing and the current efforts being made to acclimatize the so-called bloodless bullfight. As subtle preconditioning, a good deal of film footage of Mexican bullfights, which no one claims are bloodless, has appeared on United States television stations. In bulldogging exhibitions, the spectators are often soothed by the man at the microphone; Mr. Morse notes that as the steer is dragged away, sometimes as a corpse, the announcer can be heard saying, "Don't worry folks. The steer is okay. Just had the wind knocked out of him."

The author writes in a low key, almost matter-of-factly, of slaughterhouse techniques, although he does suggest that "if every one of our slaughterhouses were constructed of glass, this would be a nation of vegetarians." A chapter is devoted to what our thirty million hunters accomplish on their forays into the countryside, and also to the uncurbed animal misery associated with the peculiar business enterprise called the roadside zoo, which flourishes unregulated and uninspected.

Any concept of mercy or fairness toward animals has an emotional basis, and there is no doubt as to where the author's sympathies lie. The subject raises complicated ethical issues that the human animal generally prefers to ignore. It appears from this recital of contemporary attitudes and practices that if we do not accept the biblical authority placing the animal kingdom wholly at man's disposal, we nevertheless act as though we do.

Among the implications of this interesting survey of unnecessary cruelty is the suggestion that the way any society treats its animals is a measure of its degree of civilization. Mr. Morse writes from an authoritative background, for he has been in humanitarian work for thirty years, and is now President of the Humane Society of the United States, based in Washington, D.C., which co-ordinates and sets standards for local humane societies throughout the country. There is no bibliography, probably because the data used came not from books, but from personal experience and observation. The volume is introduced by Joseph Wood Krutch, who draws a parallel between the "unwarranted cruelty" that is the subject of the book, and "the same human indifference that threatens our wildlife, our forests, our waterways and our air." The book will be read with approval by all who have shed their insensibility to the plight of silent animals, but it is not likely to change the attitudes of state conservation department officials who play sweethearts with sportsmen's lobbies; members of the American Rodeo Association; or those "scientists" who still affirm—shades of Descartes and his theory of animal automatons—that "Science has not yet proved that animals suffer. To think they suffer is anthropomorphism."

Gerald Carson
Author

Man Discovers His Past, by Glyn Daniel. *Thomas Y. Crowell Co., $5.95; 95 pp., illus.*

As recently as the 1860's most people, in line with the teachings of theologians, believed that the earth, and man with it, was created 6,000 to 7,000 years ago. Today we think in wider terms. The earliest dated works of man have been found on the floor of the Olduvai Gorge, a miniature Grand Canyon in East Africa, and include carefully made stone tools about 2,000,000 years old. Furthermore, fossil evidence suggests that members of the family of man used tools millions of years before that.

This shift in perspective is the central theme of *Man Discovers His Past* by the British archeologist Glyn Daniel

of Cambridge University. Based on a series of informal television talks, his readable survey shows that even the most "obvious" evidence can be explained away if it runs counter to prevailing beliefs. For centuries, beautifully worked flints were regarded as the work of elves, a notion once far more plausible than the notion that men roamed the world's wildernesses in small bands before the days of Greece and Rome. Even when the stones were accepted as tools, they were attributed to the Romans or early Britons.

Opposition started fading during the late eighteenth and early nineteenth centuries. Excavators, mainly enthusiastic amateurs, pointed to material associated with the tools—fossil remains of men and extinct animals. Most geologists still thought in biblical terms, maintaining that such associations were accidental; that the Flood had mixed the bones of ancient animals with the tools and remains of recent men. But their last-ditch defenses crumbled with the finding of bones and tools together in unflooded and undisturbed deposits, including a number of important sites on the banks of the Somme River. British investigators came to check the French deposits, were convinced, and announced their conclusions in 1859, the year that saw publication of Darwin's *Origin of Species.*

As Daniel indicates, this date marks the beginning of modern research in prehistory and human evolution. He outlines subsequent advances such as the discovery of cave paintings in Spain and France, studies of the origins of agriculture, and some new excavating techniques developed since World War II. Like most books consisting of lightly edited television transcripts, *Man Discovers His Past* is repetitious in places and tends to be a bit sketchy in covering major developments, but it can be recommended as a stimulating introduction to archeology.

JOHN E. PFEIFFER
Science Writer

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Letters to the Editors

Ecology: Trivial or Pertinent

As an ecologist I am compelled to answer Peter Farb's accusation ["The New Ecology"—NATURAL HISTORY, August-September, 1968] that typical ecological research and publications deal with minutiae. Also. I would like to take issue with his implication that the small band of ecologists he lists are among the only ecologists building important "monuments to new ideas" in ecology.

First. Farb's accusation . . . is supported by his citation of an article in a current issue of *Ecology* and by the point that this specific piece of research is of little potential value to human ecology. I will counter his case by citing the following articles in the same issue of *Ecology*: "A new model for age-size structure of a population." "Stable manganese and fallout radiomanganese in animals from irrigated ecosystems of the Po Valley." "Contour maps of infestation incidence useful in epizootiology of screw worms." and "Photon flux, chlorophyll content, and photosynthesis under natural conditions." Few would dispute that these articles deal with research and concepts of considerable importance to human ecology. It is true that much of ecology remains concerned with trivia, but it is equally true that much of a sophisticated and sociologically pertinent nature is being done. The science of ecology has far to go to suit both the current and future needs of mankind, but not nearly as far as Farb implies. The discipline is rapidly maturing despite Farb's indictment.

On the second point, an inspection of the current ecological literature reveals that all but one or two of the persons listed by Farb have published little research data in the past five or ten years. This implies that these people are "thinkers" and not "doers." Without almost constant contact with field and laboratory research. an ecologist rapidly loses insight into what can be accomplished in his discipline. I submit that this is what has happened to the majority of the members of Farb's list of idea builders. True. they all continue to tell ecologists what needs to be done, but they largely fail either to tell us how to do it or to engineer programs designed to accomplish their lofty goals. In short, these people are "ivory towerists."

Fortunately for ecology, there are people who are both "thinkers and doers." but Farb chooses to ignore these people who create ideas. stimulate, guide, and participate in research, and synthesize theories from firsthar data. Among these important ecol gists are Eugene Odum, Howa Odum, George Woodwell, Robert Ma Arthur, Kenneth Watts, and Stanl Auerbach. It is upon the ambitio and achievements of such realists these that the accomplishments ar hopes of ecology rest. and not up the lofty dreams of idealists.

CHARLES R. MALO
Oak Ridge, Ten

On Daniel Boone

David Lowenthal's article "Dani Boone is Dead" [NATURAL HISTOR August-September, 1968] contains ju enough truth so that its clever arg ments will undoubtedly be quoted support of every new encroachme on our already hard-pressed nation parks. His thesis. if I read it correctl is that the wilderness must give wa to crowded campsites and the amen ties of civilization because that is wh most people want. (He also believ that most Americans still look on t outdoors as a place to throw awa their beer cans—should we therefo carry majority rule all the way ar turn our parks officially into dumps?

In support of his conclusions. M Lowenthal cites such conditions as t congestion in Yosemite Valley and t prevalence of fancy camping equi ment to prove that people must like this way. My observation is that he h confused cause and effect on the o hand. and overlooked the controlli consideration on the other. Let me e plain. In order to camp in Yosemi Valley in past years. one had to acce crowding of the kind described by M Lowenthal. I never met anyone w liked this. but we either had to p up with it or camp miles away fro the valley. This year the Superinten ent has established and enforced sen ble rules to eliminate the worst of t overcrowding. When sites are fu campers must go elsewhere. The ne system seems to be accepted by a concerned as a long overdue refor that is making the park more enjoyab for everybody. The author claims th campers insist on crowding togeth even in the winter when the parks a nearly empty. Wrong again. It is tr that the winter campers stay close t gether. but wrong that they prefer that way. My experience has been th the park authorities shut down cam grounds as soon as the park season over and force the campers to stay t gether. The effect is the result of acti taken for the administrative conve

ience of, and easing of maintenance for, the park managers. Most people of my acquaintance would prefer to spread out more than they are allowed to. Please, Mr. Lowenthal, do not tell us that campers prefer to be crowded any more than slum dwellers prefer it that way, just because that is how they are forced to live when conditions do not permit them to do otherwise.

Mr. Lowenthal cites numerous examples to prove that people like luxury in their camping arrangements. This cannot be denied. He also points out that these same people are seldom found far from well-worn paths. This is also true. We were in Yosemite over the Fourth of July weekend this year, and the valley was indeed filled with the roar of motorcyles and the smoke from fancy camping trailers. Yet, when we climbed the trail to Inspiration Point we met only one other group on the entire trip. Mr. Lowenthal would leave it at this and conclude that only an elitist minority is interested in preserving the wilderness, therefore majority tastes must be allowed to prevail. He never asks the $64 question—if the motorcylists, trailer dwellers, and lawn chair campers aren't interested in getting out to see the wonders of nature, why are they in the parks at all? The answer is that they are enjoying a vacation in the cool mountains *at minimum expense*, thanks to the federal, state, or county government that maintains the park in question. Once this is realized, the solution is ridiculously simple. Provide vacation camping parks for the majority that want such facilities. Locate them in areas where the climate is comfortable, provide electrical outlets and hot dog stands, fake ruins and artificial swimming pools and run big roads right up to the entrances. People will flock to them. Leave the national parks a little harder to get to and get rid of the honky-tonk concessions. Those who really want to study the wonders of nature will be glad to take the trouble to get there and to leave the wilderness unspoiled for future visitors.

Finally, I would like to admit that I recognize that much is true in the author's characterization of the outdoorsman, but like the rest of the points in his article it is exaggerated to the extreme. Most outdoorsmen do exhibit *some* of the characteristics he enumerates—counting and classification, self-improvement, organization, good citizenship, masochism (to a slight degree)—but practically none display them all. The only ones that practically all of them share are self-improvement and good citizenship, which is why they are able to use the wilderness without irretrievably spoiling it.

JOHN D. ALDEN
Pleasantville, N.Y.

The enchantec

This may seem an unlikely photograph. But Esso's Fawley refinery on England's south coast is an unlikely place.

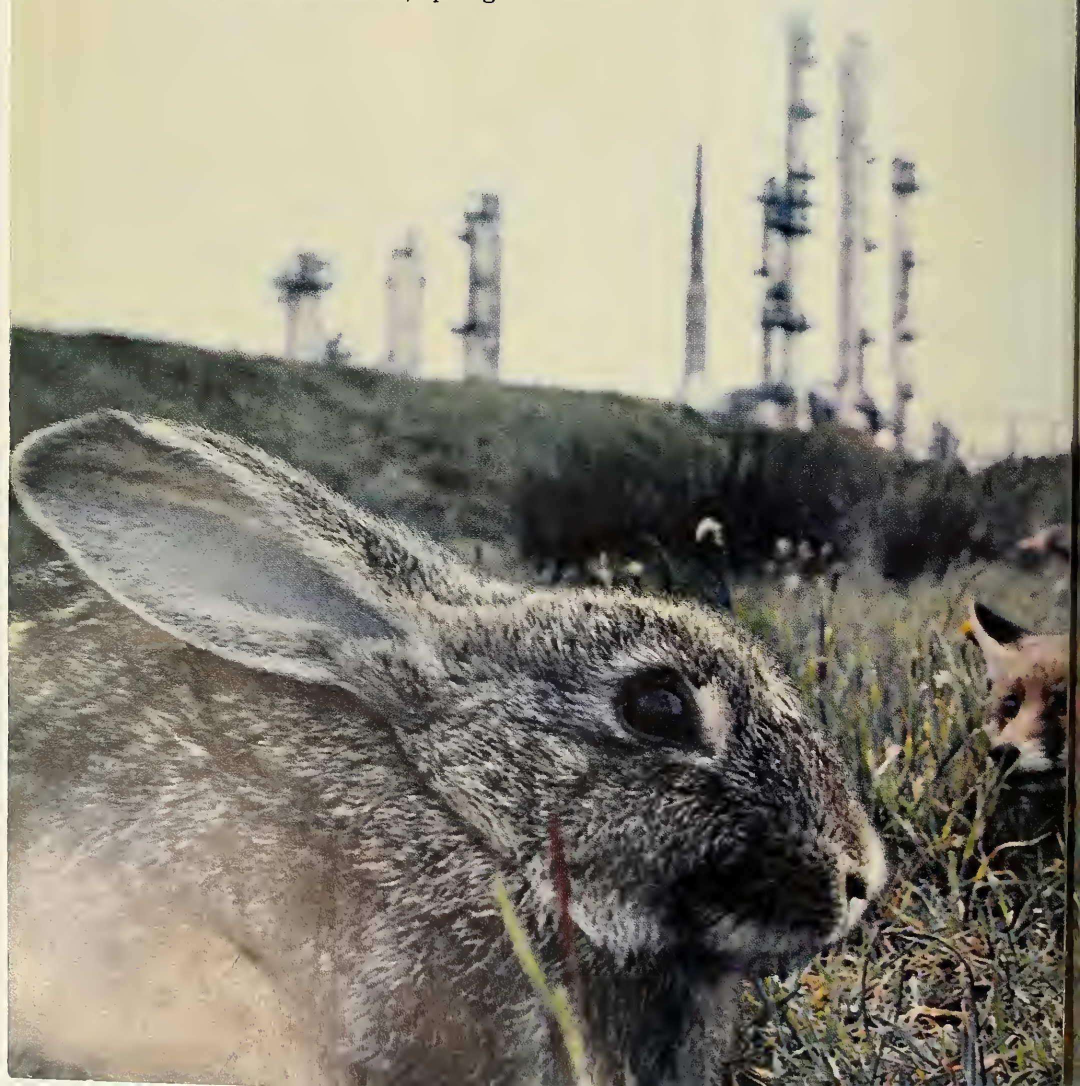
Major Oliver Kite, a prominent British naturalist, said it was one of the most remarkable examples of wildlife conservation he had ever seen. And, shortly before his untimely death last June, he finished making a film about it.

In a single year, Major Kite identified eighty-eight species of bird and twelve species of butterfly within the refinery fence.

He watched kestrels dive, lapwings tumble and kingfishers eye their royal dinners. And, May, "the nightingales sang throughout tl day." Some refinery.

He also fly-fished.

He hooked a two-pound trout from tl refinery's cooling lake. And, even at the jettie where tankers unload sixteen million tons of a year, he found nature just as ebullient. "Th is where flounders provide food for the reside



oil refinery.

ormorants and charms of goldfinches feed on he seeding thistleheads."

Fawley's foliage impressed him too. When ersey's Esso affiliate built the refinery, they lanted twenty-six thousand trees and shrubs o screen it from the road. This tree belt now rovides woodland runs for squirrels, moles and oxes.

And, sometimes, even a wild pony wanders in. Perhaps to admire the rhododendrons.

What does all this prove? Simply that an oil refinery can be a good neighbor. It needn't be ugly. It needn't disturb the peace. It needn't soil the air, the land or the water. And it needn't upset the balance of nature.

Fawley isn't exactly a vacation spot. But it's nice to think that so many living things find it a good place to raise a family.

Standard Oil Company (New Jersey)

Suggested Additional Reading

DWINDLING LAKES

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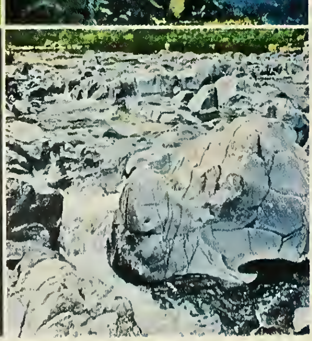

Another in Sinclair's American Conservation Series

Missourians saved a place for you...and a whole new idea in conservation was bor

This spellbinding part of the Ozarks cradl prehistoric man. In a johnboat, your gui floats you down the Current River, pa enormous springs, through dramatic ca erns. Along the way you catch bass, sm wildflowers, walk where mammoths d You camp by moonlight and the riv chuckles you to sleep.

To share the experience with fello Americans, Missourians invented a co cept, the National Scenic Riverway—a riv and its shores for a short distance inlar preserved in its natural state. And they c it with land that once nearly died of abu Timber had been stripped away, soil h washed off, streams had filled with grav Animals and vegetation vanished, and 1930, so had many people.

Finally a group of native folks includi Leonard Hall, distinguished conservati writer, decided to *do* something. They ganized the Ozark National Parks Assoc tion. They spoke, met officials, testified Washington before Congressional Comm tees who listened and believed. They g help from Missouri's Senator Symingt and Congressman Ichord. Other Senat and Representatives visited the area a Secretary Udall even floated the river.

Meanwhile, Ozarkians had fought b soil practices with good forestry...a watched leaves turn to humus, humus soil. Vegetation took root again and wi life began returning. By 1965, the area w becoming a paradise once more—as well our first National Scenic Riverway.

Sinclair believes that we all have a sta in preserving our natural environment a its beauty. We hope these accounts of p vate citizens—such as those in Missou will inspire other Americans to action their communities. Let us help plan a t to the Ozarks, to *any* of our National P areas, or any place in the U. S. A. Wi Sinclair Tour Bureau, 600 Fifth Aven New York, N.Y. 10020—Dept. H

Discover America by Car—It's Worth Seeing and Saving

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DECEMBER [illegible]

Natural History

By 1978, cars will be less of a smog

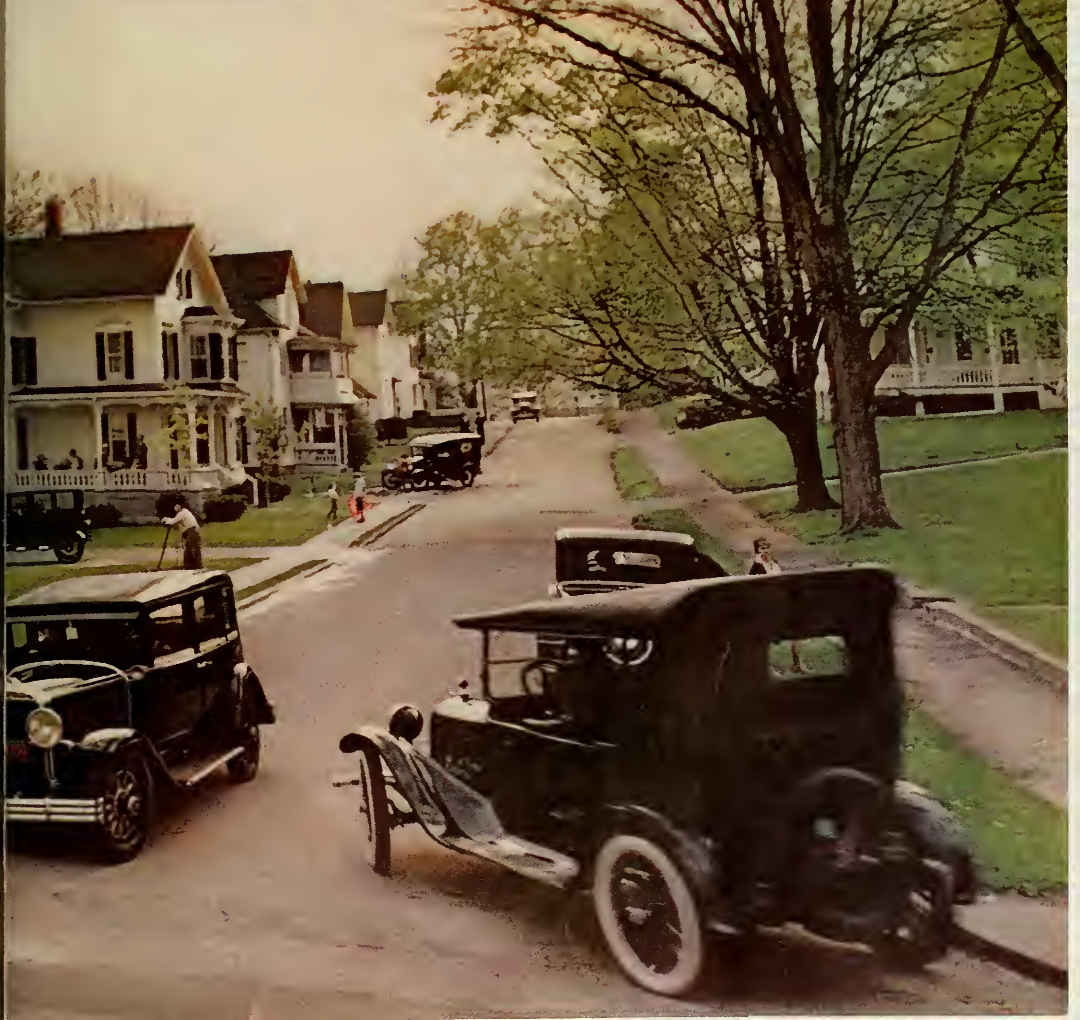
Some people think of the twenties as the golden age of motoring. They have a point.

We drove on wiggly roads instead of turnpikes. Fifty miles an hour was heady stuff. Cars were reasonably reliable but still slightly adventurous. And there weren't many of them. Who cared if they smoked a bit? The blue vapors floated up to the blue sky and disappeared. Or seemed to.

By the fifties, things were different. There were twice as many cars. And a new word had entered our vocabulary. Smog. The car's contribution to this phenomenon had become a problem to be taken very seriously. Rightly s

By 1978, there will be six times as ma cars on American roads as there were in t late twenties. Will the exhaust problem be s times worse? The answer from Jersey's affiliat Esso Research, is a resounding no. Here are few incontrovertible facts.

Air pollution from cars reached its zeni last year. We have now passed the turning poir Despite the car population explosion, total e haust emissions will go down this year—furth down in 1969—and further and further dow in all successive years.



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THE AUTHORS

Currently Program Officer in charge of resources and environment at the Ford Foundation, Gordon Harrison is a veteran of long experience in journalism and government service. In 1950, after receiving his Ph.D. in American civilization from Harvard, he became civilian historian for the War Department. He has also been chief editorial writer for the *Detroit News*, press attaché at the American Embassy in London, and a member of the editorial board and assistant to the publisher of the *New York Herald Tribune*.

David M. Gates, a chief speaker at the Ford Foundation's press conference to announce grants in ecology, is Director of the Missouri Botanical Garden and Professor of Botany at Washington University. In 1955 Dr. Gates's research in atmospheric physics resulted in his being the first person to record the infrared spectrum of the sun by sending instruments aloft by skyhook balloons. His later work has been on environmental influences of climate on plants and animals in terms of energy transfer. He is a lecturer of international reputation and has published one book and more than one hundred research papers in physics, botany, and ecology.

Working at his 150-acre country place near Millerton, New York, Gerald Carson has produced several books on social history and popular culture. His latest work is *The Polite Americans* (William Morrow & Co., 1966), and he is the author of *Cornflake Crusade* (Rinehart & Co., 1957), which touches upon various aspects of vegetarianism. Mr. Carson has written two other articles for Natural History (December, 1967 and April, 1968) dealing with the relationships between animals and humans.

William G. Conway's interest in zoos began when he was a preschooler with a home zoo, and he ha never ougrown this interest. His pro fessional career began as Curator c Birds at the St. Louis Zoo, and i 1956 he came to the Bronz Zoo in th same capacity. He was later made zo director and is, at present, Gener Director of the New York Zoologic Society, which includes the Zoo, th New York Aquarium, and associate scientific institutes. Mr. Conway ha made many field and collecting trip and has written more than sixty a ticles, both popular and technical, o zoos, ornithology, and conservatio

Lee Boltin was staff photogr pher for several years at The Amer can Museum of Natural History. A a free-lance photographer, he ha done assignments for Natural Hi tory and other leading nation magazines. Best-known for his pho tographs of sculpture, he is currentl working on two books: one o Rodin; the other on crèche figures.

The careers of Thomas D. Broc and Mary Louise Brock have take them to Iceland, the Azores, Ital Scotland, and Yellowstone Nation Park. Dr. Brock is presently Profe sor of Microbiology at Indiana Un versity in Bloomington, and the au thor of over fifty research papers an two books, *Milestones in Microbio ogy* (Prentice-Hall, 1961) and *Prin ciples of Microbial Ecology* (Pren tice-Hall, 1966). Mrs. Brock is Research Associate in the Depar ment of Microbiology, Indiana Un versity, and has coauthored many re search publications with her hus band.

Ruth Kirk, a free-lance write and photographer, has written te books, including *The Olympic Rai Forest* (University of Washingto Press, 1966), and numerous article on natural history and travel. Sh received an award from the Governo of Washington for writing that "ad vanced the cultural awareness of th state." Mrs. Kirk and her husband Louis, a naturalist and ranger wit the National Park Service for twenty one years, have done several article and picture stories for *Nature an Science*, the Museum's magazine fo children.

David M. Gates

Gordon Harrison

Gerald Carson

William G. Conway

Ruth Kirk

Lee Boltin

Thomas D. Brock and Mary Louise Brock

Ecology

That all things in the universe are intimately related is an ancient but still pervasive thought. Plato conceptualized this relationship, as did many later thinkers in the Middle Ages, the Renaissance, and even the eighteenth century, as a vast hierarchical chain. Not even today has it been banished as a popular notion of the moral order of the living world. Here is a short account of the chain by John Fortescue, a fifteenth-century jurist:

"In this order hot things are in harmony with cold, dry with moist, heavy with light, great with little, high with low. In this order angel is set over angel, rank upon rank in the kingdom of heaven; man is set over man, beast over beast, bird over bird, and fish over fish, on the earth in the air and in the sea: so that there is no worm that crawls upon the ground, no bird that flies on high, no fish that swims in the depths, which the chain of this order does not bind in most harmonious concord."

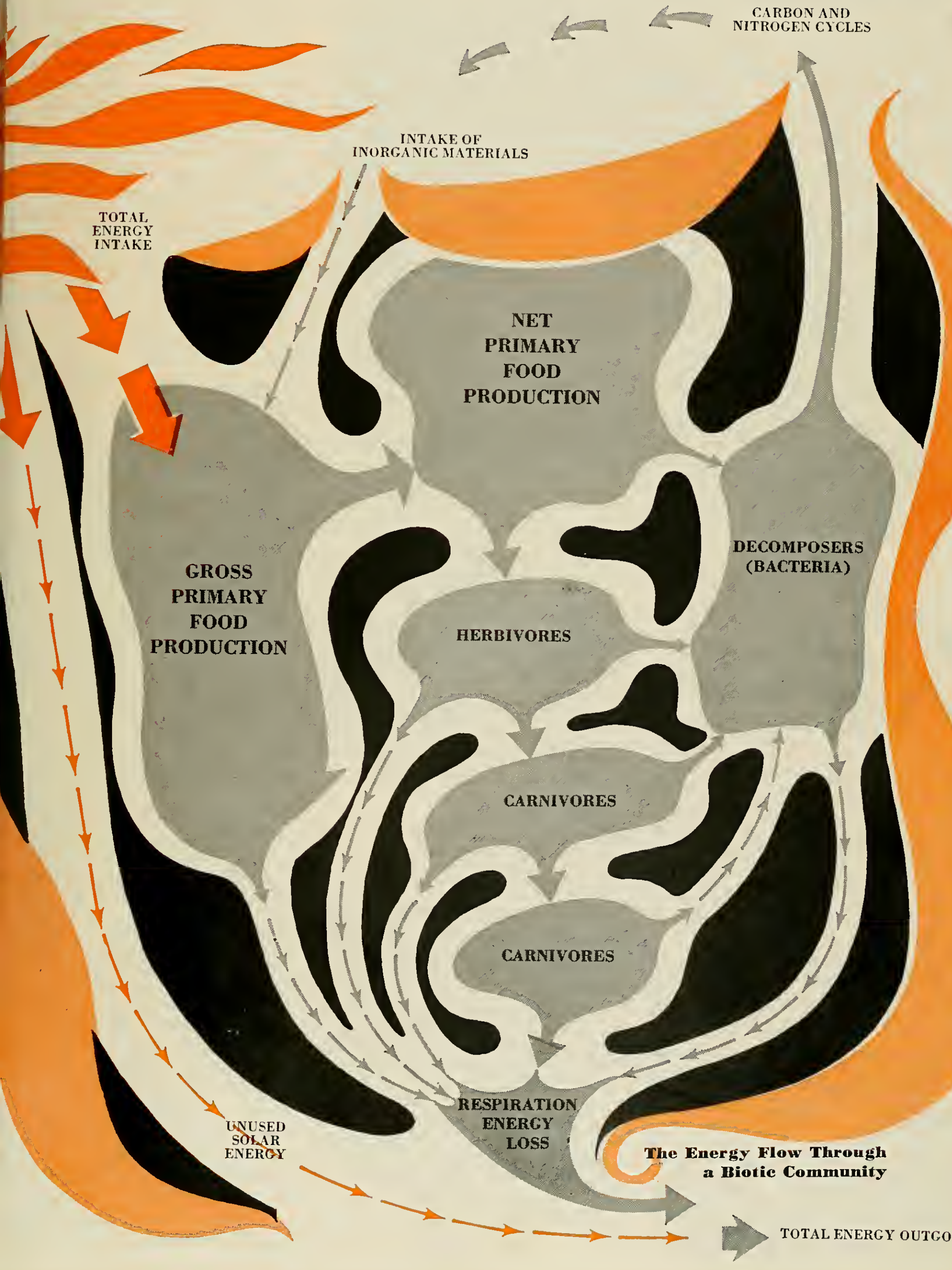
We are now, in mid-twentieth century, redefining and relinking the great chain. But instead of a system of rank based on a philosophical or theological scale of values, we are developing a system that recognizes the actual workings and consequences of relationships—such as those between chemicals and organisms or between organisms and organisms or between organisms and the places where they live. While many of us still tend to endow the word that describes the science of the new chain—and that word is ecology—with mystical properties, the fact is that the science itself is concrete, precise, and empirical. Nevertheless, it is reordering our conception of the world, of the chain, as profoundly as a great religious idea might.

There has, in NATURAL HISTORY, *been discussion of the matter of ecology. Peter Farb's book review in the August-September issue drew a sharp response in Charles Malone's letter to the editor, which was published in the November issue. Then, the proceedings of a press conference held some five months ago by the Ford Foundation to announce almost 4 million dollars' worth of grants for ecology came to our attention. Two thoughts struck us. First, despite some newspaper coverage of the conference, we felt that the significance of such large grants to ecology had not been sufficiently emphasized by the press. Second, the proceedings themselves contained as clear and as eloquent a description of the workings of ecology as we had ever read. We therefore feel not only obligated to publish, in slightly briefer form, the transcript of the press conference, but we also do so without the slightest embarrassment over its belated appearance. The new great chain of being is starting to be perceived and we celebrate the perception. — The Editors*

Gordon Harrison, Program Officer, Ford Foundation: Ecology has been defined as the science of the interrelationships of creatures to each other and to their environment. There are many other ways of saying the same thing. I was talking recently to a biologist who had served for five years as a pest control officer in Borneo. He told me that some years ago the World Health Organization launched a mosquito control program in Borneo and sprayed large quantities of DDT, which had proved to be very effective in controlling the mosquito. But, shortly thereafter, the roofs of the natives' houses began to fall because they were being eaten by caterpillars, which, because of their particular habits, had not absorbed very much of the DDT themselves. A certain predatory wasp, however, which had been keeping the caterpillars under control, had been killed off in large numbers by the DDT. But the story doesn't end there, because they brought the spraying indoors to control houseflies. Up to that time, the control of houseflies was largely the job of a little lizard, the gecko, that inhabits houses. Well, the geckos continued their job of eating flies, now heavily dosed with DDT, and the geckos began to die. Then the geckos were eaten by house cats. The poor house cats at the end of this food chain had concentrated this material, and they began to die. And they died in such numbers that rats began to invade the houses and consume the food. But, more important, the rats were potential plague carriers. This situation became so alarming that they finally resorted to parachuting fresh cats into Borneo to try to restore the balance of populations that the people, trigger-happy with the spray guns, had destroyed.

Now this interesting tale illustrates some critical ecological facts. One is the extreme complexity and far-reaching character of the interrelationships based on the stomach:

'he New Great Chain of Being



the question of eating and being eaten. Second, that populations of creatures, who evolved in association with each other over a long period of time, have a relative stability, provided their environment also has a relative stability. When that environment is violently and suddenly altered, as by the introduction of DDT, the systems tend to break down. Third, that all materials—food, minerals, water, and so on—in any natural system are constantly recycled. If you introduce into that system a material that is not biologically degradable, such as the chlorinated hydrocarbons, the material stays there and tends to concentrate the farther up the food chain you go, which is why, among the bird species, which are particularly threatened by pesticides, the most seriously threatened are the predators—the eagles, the ospreys, the hawks, and so on. The fourth lesson from this little tale is that man's one problem–one solution approach to his environmental dilemmas inevitably courts disaster because it ignores the complexities of the living material with which he deals.

This is a long way to the point, which is simply that ecology has a practical significance for people. It's perfectly clear that man has to exploit his environment; he has to deliberately unbalance the natural system, because, in effect, unbalancing is the only way he can produce a surplus—the crop on which he ultimately depends. Having unbalanced the system to produce a crop, he must obviously protect that unbalance. One of the many ways in which he protects it is by spraying pesticides. So, we're not saying, and I don't think anyone who takes a reasonable view of this situation would say, that these things may not happen. If man is to continue to exploit the natural living systems to his advantage, then his first prescription is to take steps to see that those systems stay around to be exploited. They have certain health requirements themselves, which a sensible policy ought to preserve. It is ecology that provides us with an understanding of the workings of these natural systems and that will permit us, if we are politically and economically sensible, to manipulate them in such ways that they do survive.

With its new methods for modeling living systems, ecology offers

ıan an immense practical advan-
ıge: he does not have to go through
ıe tragic procedure of altering the
nvironment, finding that catastro-
he results from it, and then trying
ɔ undo that catastrophe. By mathe-
ıatically simulating the relation-
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vay, models can be applied not only
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vant to know, for instance, how
nany salmon you can safely fish,
vhen you ought to fish them, and
vhat controls ought to be put on the
fishing so as not to destroy the re-
source itself. These complicated interrelationships—not only biological but economic and political—can all be translated into mathematical terms, put in a simulation model, and management techniques tested. There's nothing new about this. The military has been doing it for a long time and so has business. There are technical difficulties, but on the whole, the principle is simple enough. The application, however, is just beginning to get under way. All that I have said is simply background for answering the question why ecology is, in our opinion, a basic science for environmental management. The primary purpose of grants, therefore, is simply to make it financially possible for good scientists to respond to this challenge. We feel confident that the problems that we're helping the universities to meet are problems that are going to be with us for a long time. And, indeed, they are going to get a good deal worse because of the proliferation of population and because the cures now being proposed and applied are clearly insufficient. The reason we think these are durable problems over the next several decades is that they are not the result of wonders or accidents so much as they are directly products of our management of the systems. There is an essential conflict between man's need to exploit the environment and nature's need for balance and stability, and the only way we are going to resolve the conflict is to try to understand what is happening and to operate in such a way as to assure a maximum stability in nature where it is economical to do so.

One way to look at ecology is not only as a method and technique but as a point of view. However meager our knowledge may be, however embryonic our sense of the mechanisms of control may be, the fact is that there are ramifying consequences from our actions, such as spraying DDT or building a dam or a highway or subdivision. In short, man's intervention in nature is like throwing a monkey wrench into a machine, but the machine is so interlocked and so complicated that the consequences are never local; they are always general. The sensible course is to try to limit exploitation to what is absolutely necessary and to pause and think of the consequences of our intervention. The developer doesn't have to cut every tree on the lot; he doesn't have to pave every street to every half-acre. There are better, less disturbing ways of doing many things in nature. Essentially this involves educating people and prompting resource managers to ask themselves the right questions about their jobs. The Foundation has supported some educational programs, and we will continue to try to develop the habit of asking ecological questions. The second thing that we are trying to do is to strengthen what I call the "think twice" mechanism: those instruments that compel or persuade people to pause before engaging in vast environmental engineering projects. One of these mechanisms is the conservation organization, whose essential role is to say "stop and think." We are particularly interested in supporting such organizations in their efforts to become more professional, in their efforts to integrate themselves into more effective groupings—effective both from an education point of view and from a political action point of view.

A second think twice mechanism is land preservation itself—the buying of land and holding it open either because it is particularly valuable to people for open space or because it is easier to reverse a decision that holds land open than it is to reverse a decision that develops it. So one can justify a good deal of land acquisition and preservation simply on the grounds of holding open some options for future generations. Now, we realize that the expense of land purchase is such that this must basically be public responsibility, but we have already experimented with a device for using private funds for the purchase of lands that are destined for public acquisition. In this way, we get in ahead of the bulldozers or the speculators and end up with more public land for fewer tax dollars than would otherwise be the case. And, finally, a third mechanism we have begun to look into is the use of the law as an instrument both of action in preserving the environment and for public education. You're familiar, I'm sure, with the Storm King case in which some individuals opposed a power plant being built in the Hudson Highlands. The case brought out a new judicial doctrine, a new order to the Federal Power Commission. It was no longer to be simply an umpire between opposing interests, but had a responsibility, on its own initiative, to look into alternatives for the public interest. Another recent case, involving a request for an injunction against spraying, had the very interesting effect of bringing out into the open various officials in the government whose voices had been smothered by bureaucratic consensus. And, besides litigation and court cases, there is a big job, we believe, to be done in reviewing legislation at federal, state, and local levels. For instance, is zoning legislation really the most effective way of preserving the environment?

Dr. David Gates: It's necessary that we understand the complexities of the ecosystem in every way possible. The natural environment of plants and animals is not only diverse, as Mr. Harrison has said, but it has a built-in plasticity. It can take climatic shock and adjust to it; it can take the outbreak of some pathogen or some virus disease; it can take many things that are subjective to the system and because of the diversity of organisms, the complex structure, it shifts the population density, it shifts its character, but yet it survives. When we have a hot, dry summer in the American Midwest, it's not the native forests or the native grasses that drop back or suffer. To a serious degree, it's the crops—corn, wheat, and oats—the monobiotic culture that man has replaced the natural environment with.

We do not understand today some of the simplest things about the relationships between plants and ani-

e Cossums aren't trying to save the world.
t a little piece of it.

ter Davis is a friendly, dark-
le boy whose smile can light
ntire room. But for most of
ears, he hasn't had much to
out.
ter lives in Laurel Creek, an
chian town of 200 people in
y with a per capita income
7 a year. Like most of the
eople of Laurel Creek, Lester
a three-room weatherboard
along with his mother and
and nine brothers and sisters.
ave no well, and of course no
plumbing. So Lester's mother,
carries all the family water
n the nearby creek.
ster's father, Ray, used to work
coal mines, but since the
'played out" he's been unem-
. As Tressie admits, "It's aw-
d going. We never could get
ood start before." They still
n't have a "start" if it weren't
Cossum family.
l and Martha Cossum live in
rban community of contem-
homes. Looking out back you
e one of those large, above-

ground plastic swimming pools. And you can see the beginnings of a redwood deck around the pool, which Ed and his two children, Bill and Carol, are
ng themselves.
d is a systems analyst. He
s most of his day thinking
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living in Appalachia.
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s a gift, or charity, but as a loan.
nterest-free loan which Lester's
r can borrow to begin a self-
project.
Mr. Davis already has a project

sums' money to buy and feed two cows, then sell the calves as they come along. As Mr. Davis says, "A man likes to find ways to take care of his own family."

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mals and their environment. We can see that some plants grow on the tops of mountains, where it's cold and windy. Other plants grow in the desert and others in the eastern forests, but we don't understand precisely why these plants are where they are in the particular species, in the particular association. We don't understand why weed plants move into disturbed areas as they do and begin to take over the countryside.

These problems are exceedingly difficult and they are problems that involve all of science. We have to marshal our wits, to use physics, chemistry, mathematics, and every bit of our understanding of the world about us. This is the very thing that makes ecology a difficult, elusive subject. It is really much easier to build a telescope to look at the stars or to build a rocket and put an object on Mars or the moon than it is to understand the landscape about us. We've had a very polarized science in which enormous emphasis has been placed on technology, on the physical sciences, on looking at the nucleus, on looking at the Galaxy. And this is great; we need to do this and we've benefited in many ways. At the same time, we must realize that these are things that can be done any time in the future if we are here to do it. But the dynamics of the green earth may not be here. The impact of man on the surface has been so destructive, so devastating in so many ways that if we do not give dramatic attention to these issues of life and environment, we're not going to be here to look at the nucleus or to study the Galaxy or to wonder about Mars.

In our program in St. Louis, at the Missouri Botanical Garden we are training young people in modern biophysical ecology. We are trying to bring to bear on this training the essential aspects of physics, chemistry, and mathematics. You might find it interesting that, until very recent years, we did not even understand how a plant leaf was coupled to its environment. You might say, "Well, it's obvious. There's temperature, there's wind, there's moisture, there's rain and sunlight." Indeed, but precisely how, what does it mean? It turns out that there is only one way that these things can have meaning. And that way is in terms of energy. Every last event in the life of any organism does work and con-

mes energy. If the environment is ɔing to have any influence on the ant, it must be through the flow of ıergy. And it has only been in the st few years that we've been able express these things in a self-ɔnsistent framework in terms of ıergy. Wind transfers energy by king away heat. Radiation, sun-ght, and radiant heat from the alls in a room are absorbent and ıat's energy. And that energy is es-ɛntial for the biochemistry, the ıetabolism, that goes on within. ɪnly in recent years, have we under-ood these things to the point where e can begin to make progress in nderstanding why certain plants row where they do, and how they ompete for water. Water is essen-ial; in many areas of the country, t is the limiting natural resource. Ve are beginning to understand how he soil and plant cover of a region f the country affects the water sup-ɔly, because energy evaporates vater, puts it into the atmosphere, akes it away from our use. Thus t is essential that we know whether o plant grasses or trees or shrubs; vhether to leave the soil bare or to ɔave it if maximum use of the water s wanted for some area.

At the Botanical Garden, in the raining of young people for Ph.D.'s in this area, we're trying to under-stand specifically, piece by piece, how the system works. There is no such thing as the climate of a tree. There is a climate of the top of the tree and of the side, the bottom, and the interior, and we're literally tak-ing the system apart and evaluating it. Then we reconstitute the whole system. We do this because if we un-derstand the parts, we can begin to understand the whole.

There is another great aspect of the problem that's been challenging to us—the animal world. Why are they where they are? Why do they react the way they do? Why are they located in the food chain where they are? Why do birds migrate? It used to be said that the scientist could prove that the bumblebee wasn't capable of sustained flight, but it flies. Well, literally, we haven't understood these things. Very re-cently, during just the last year, we have taken this energy concept for evaluating radiation, wind, air tem-perature, and moisture. We are try-ing to understand how a man or any animal—a horse, a sheep, a bird, a

cockroach, or whatever—is coupled to his environment. And more specifically than that, if you are a blackbird and you're black and you have a certain form and shape and a certain amount of insulation due to feathers, a certain amount of fat and a certain metabolic heat and you insist for survival that your body temperature stay at about 100° F., where can you live? What are the limits? Do you have any choice? Can you live in the Arctic? Can you live in the tropics? Usually not, because the properties that are built into you require that you live within a certain climatic niche.

Now, this climatic niche is complicated, because in its simplest form are four variables: radiation, wind, air temperature, and moisture. That's a four-dimensional space. A tabletop has two dimensions, a room three, but to even begin to take an ecological problem of a plant or animal, we're dealing with four dimensions, all time-dependent, all changing. We've only recently gotten to the point in our work where we can predict that a particular animal, and I can name some of them, must have a certain climate with certain properties: so much radiation, so much wind, a certain air temperature, certain moisture. This is exciting; it's important because from this we can begin to understand for the first time the distribution of many animals on the face of the earth. Some can be in all climates; others can exist only in very, very narrow climates indeed. And if that particular animal is a carrier of some disease, it's rather important that we understand the reasons for its confinement or its limitations in order to deal with the disease.

Man, as the end product of this evolutionary chain, depends in many ways upon all the products of evolution, both the animate and the inanimate. And to forge ahead in this world, as we're now doing; to expand our cities and our populations; to travel everywhere and occupy all segments of the globe, without understanding, is an exceedingly dangerous thing. All we're asking, all we're struggling for at the moment, is that we understand, fundamentally, these ecological issues. This is imperative. If we understand, it doesn't necessarily mean we will survive; it doesn't necessarily mean

Continued on page 60

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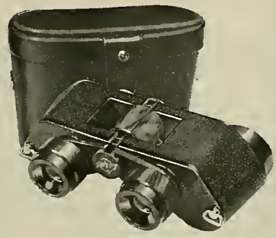

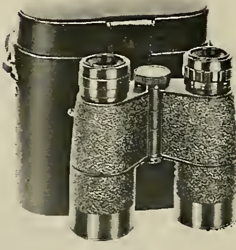

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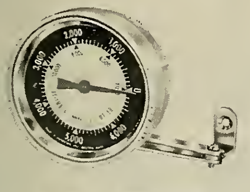

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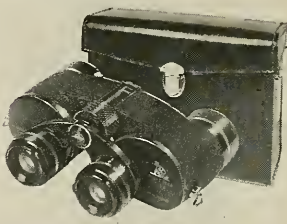

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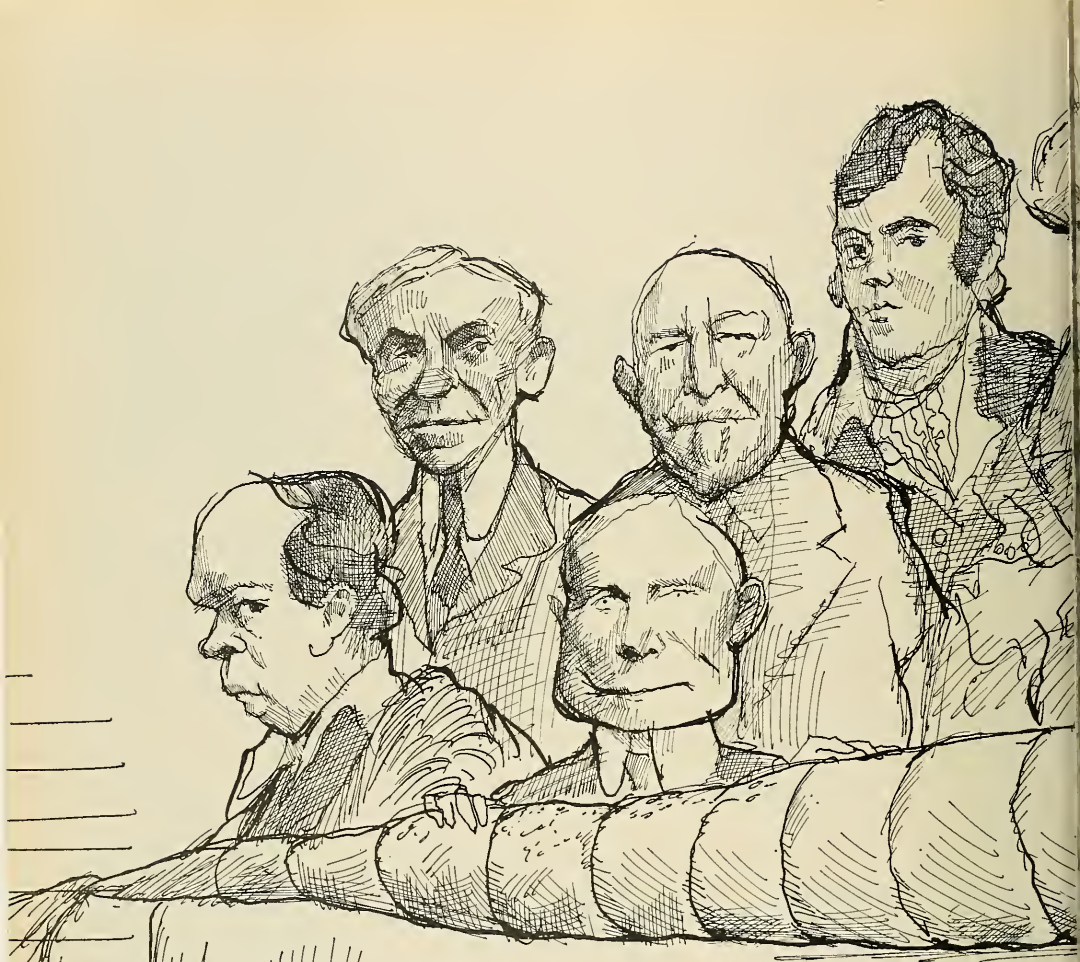
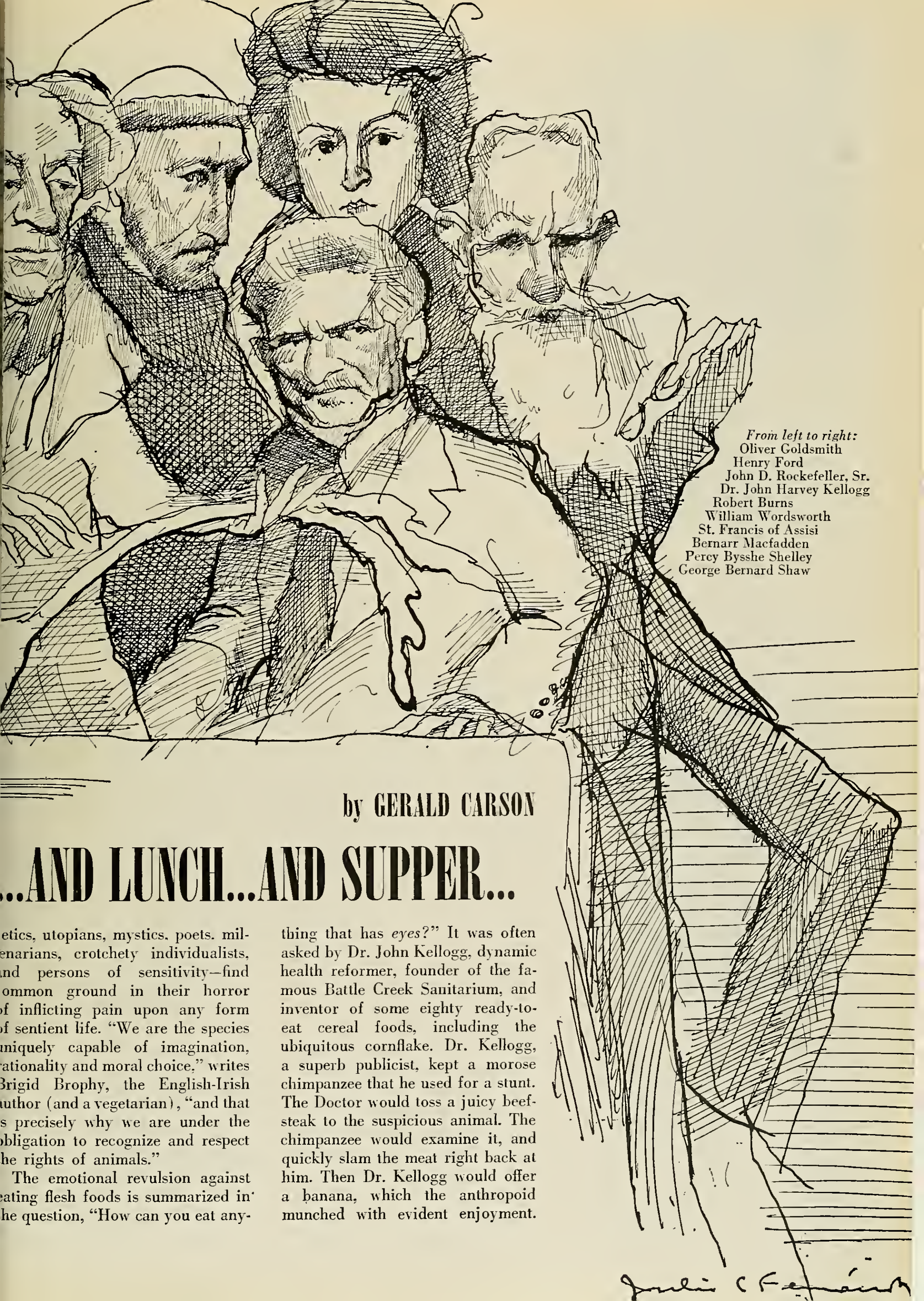


VEGETABLES FOR BREAKFAST

"We're just like other people, only we don't eat meat," the earnest President of the New York Vegetarian Society protested some years ago. But there is abundant evidence that the more than 4,000,000 persons in the United States who gather under the vegetarian banner are quite special people, for they are united by a resolve not to eat our relatives, the lower animals.

As an organized Western movement, the no-meat doctrine came into public view about a century ago; the word "vegetarian" dates from 1842. Yet the idea itself is endemic. In the long historical view, it rep resents a form of perfectionism touching the mind, the body, an the spirit. This view of man's natur is both pessimistic and nostalgic blending the dream of a vanishe Golden Age with the Hebrew stor of the fall from a state of grace. T this legendary inheritance is adde a romanticism that seeks to recaptur a lost innocence and calls up vision of straw-eating lions and tigers, n longer red in tooth and claw.

Although the vegetarian move ment is anything but monolithic, it followers—comprising reformers, as



From left to right:
Oliver Goldsmith
Henry Ford
John D. Rockefeller, Sr.
Dr. John Harvey Kellogg
Robert Burns
William Wordsworth
St. Francis of Assisi
Bernarr Macfadden
Percy Bysshe Shelley
George Bernard Shaw

by GERALD CARSON

...AND LUNCH...AND SUPPER...

etics, utopians, mystics, poets, mil-enarians, crotchety individualists, and persons of sensitivity—find common ground in their horror of inflicting pain upon any form of sentient life. "We are the species uniquely capable of imagination, rationality and moral choice," writes Brigid Brophy, the English-Irish author (and a vegetarian), "and that is precisely why we are under the obligation to recognize and respect the rights of animals."

The emotional revulsion against eating flesh foods is summarized in the question, "How can you eat anything that has *eyes?*" It was often asked by Dr. John Kellogg, dynamic health reformer, founder of the famous Battle Creek Sanitarium, and inventor of some eighty ready-to-eat cereal foods, including the ubiquitous cornflake. Dr. Kellogg, a superb publicist, kept a morose chimpanzee that he used for a stunt. The Doctor would toss a juicy beefsteak to the suspicious animal. The chimpanzee would examine it, and quickly slam the meat right back at him. Then Dr. Kellogg would offer a banana, which the anthropoid munched with evident enjoyment.

Kellogg drew the conclusion: "Eat what the monkey eats . . . our nearest relative."

Closely linked to the emotional objection to meat is the esthetic. To a vegetarian, the emanations from animal and fish carcasses are revolting, and vegetarian writers have often suggested that each meat eater should have to kill and eviscerate his own animal. One pamphleteer has advised that when a child asks questions about the source of meat the honest parent will not "conceal the origin of 'mutton' or 'beef' from a child." Combining the emotional and esthetic retreat from meat, Voltaire asked, in his article on "Viande" in the *Dictionnaire philosophique*, whether, if animals had speech, we would dare to kill and eat them. The philosopher saw in his imagination a lamb at the slaughterhouse imploring the butcher "not to be at once assassin and cannibal." In support of this position vegetarians employ vivid images of "the pitiful organs and limbs of the creatures" freshly slaughtered. Dr. Kellogg never failed to allude, with gut realism, to any carcass displayed in a meat market. In his lectures, the Doctor gleefully recited unappetizing statistics on disease, gathered at the Union Stock Yards in Chicago, or he would whirl on his audience to bark, "How would you like to eat a dead hen?" Vegetarian publicists also discuss—in grisly detail and with a certain relish—the parasites that inhabit animal flesh consumed by humans, including the tapeworm, and the occurrence in pork of the nematode *Trichinella spiralis*.

While vegetarians are, on the whole, sober and preoccupied people who are carrying a good deal of intellectual baggage, at times they do enjoy a joke. For instance, a vegetarian, seated in the dining room of a hotel, addressed himself to his breakfast egg. A non-believer, seeing a chance for a thrust, asked what he would do with the egg if he found a chick in it.

"Why," said the vegetarian, "I would hand it over to you."

Mel Morse, President of the Humane Society of the United States, who advocates mercy toward animals but is not personally a vegetarian, remarks in his recent book, *Ordeal of the Animals*, as he sketches a slaughterhouse scene, "if every one of our slaughterhouses were constructed of glass, this would be a nation of vegetarians."

The animal-defense movement and vegetarianism often pursue parallel aims, although the SPCA's and humane groups do not usually object to what they call "necessary killing," provided thoroughgoing humane procedures are followed in killing for food or for the painless disposal of unwanted or homeless animals. In contrast to this position, the vegetarians do not recognize the concept of "necessary killing."

They often meet life's complexities with versatile responses. One prominent vegetarian, whose wife discovered that she missed the taste of bacon, developed a type of smoked yeast that tasted like bacon, then found that he had a prosperous new business on his hands. Another, when asked what he would do about the plague of rabbits in Australia, replied, "If I could not live in the country with the animals, I should go somewhere else."

The ethical vegetarian—who refuses to eat meat or take life on moral or philosophical grounds—appears in Bronson Alcott, the New England sage and mystic, most transcendental of the Transcendentalists. When he went to the meat shop to market for his wife, Alcott shuddered, "Death yawns at me. . . . The death-set eyes of beasts peer at me and accuse me." At his vegetarian communal farm, "Fruitlands," Alcott prohibited the use of woolen clothing because it deprived the sheep of its coat. Nor did he approve of his fields being cultivated by oxen or horses, since such slave labor would have violated the natural rights of animals. Thomas Carlyle, who both laughed at and loved Alcott, described him as a man "bent on saving the world by a return to acorns and the golden age."

This same line of reasoning has led idealistic vegetarians, who relentlessly follow their premises wherever they may lead, to reject shoes and gloves made of leather and to avoid soap and cosmetics made from animal fats. When the International Vegetarian Union met in London some years ago, one of the delegates wore a derby hat made without silk. Another displayed "vegetarian" furs. Exhibits included pocketbooks of vegetable origin, and dog collars, "tortoise-shell" combs, and strings for tennis rackets and

violins made without sacrifice from any animal.

The vegetarian is generally a reformer before he is a physiologist, connected sympathetically with other altruists in such individualistic groupings as the anti-fur-wearers, the anti-tobacco and temperance movements. Vegetarians occupy a position near to that of the opponents of vivisection and compulsory vaccination and are frequently stern critics of orthodox medicine. They emphasize that their diet promotes world peace. Meat makes men want to fight, according to some vegetarians who believe that we become what we eat. This is a residue of primitive man's sympathetic magic. Eat brains to have brains, the heart for courage, the deer for swiftness. Carnivores are killers, therefore men who eat meat take on the same characteristics. The theory is inadequate. Actually, the grass-eating African buffalo is more vindictive than the lion. Why are tigers fierce? Simply because they are tigers!

Vegetarianism must be viewed in part as a theological attempt to explain the cosmos, for it contains elements of metaphysical speculation, pantheism, yoga, and Vedic mysticism. For example, Mrs. Annie Besant, the nineteenth-century theosophist and author of a vigorous little work, *Vegetarianism in the Light of Theosophy*, is still cited in the literature read by vegetarians. She describes how she felt a profound depression of spirit when she was coming into Chicago because she was receiving astral messages of reproach from the spirits of thousands of beasts murdered in the South Chicago yards.

One of the revered father figures of the movement is Sylvester Graham (1794-1851), a verbose and belligerent promoter, on an empirical basis, of the nutritional values of the whole-grain cereals. Graham rested the vegetarian position on both the Scriptures and science, drawing his conclusions from a comparison of human dentition with the similar equipment of the panther, the camel, and the orang-utan. Graham also denounced meat as a stimulant of sexual vigor, which probably had quite a different impact upon his lecture audiences than he had contemplated.

Physiologically, man stands between the highly specialized herbivores, which have long, capacious intestines and a large caecum, and that do little but browse and rest, and the carnivores with their shorter tract and small caecum. Some vegetarians are strong and healthy men. So are some people who fancy beef and bourbon. The vegetable diet has, despite the criticism of many nutritionists, ranked up many impressive accomplishments. One has to look, however, at more than the food regimen to find the reasons. Attention to health, backed by a theory and a scheme, usually brings in supplementary factors, such as rest, a better environment, and an improvement in general habits. As Dr. L. Jean Bogert wrote in *Diet and Personality*, "The suggestion and belief that benefit will be derived is . . . a strong force making toward health."

The true spiritual vegetarian, as distinct from the stomach vegetarian, believing that each animal has its place in the evolutionary order, its own life to live, its own joy and vivacity, considers that it is unethical to consume *any* product of animal origin. Thus from the strict point of view, those who use milk, butter, cheese, eggs, and honey are regarded as no more than demivegetarians, to whom the undefiled say crossly, "You may as well eat the Devil as drink his broth." For those who are sympathetic but unreliable in practice, the Vegetarian Society of New York provides a special, but inferior, class of membership.

There are other complexities and subgroups. Fruitarians eat only what the term indicates. Some vegetarians have survived on nuts. Others eat only plant life that is organically grown. Another division subsists on raw foods only, while some will eat only the "aspiring" vegetables that grow in the light of the sun—no tubers or root vegetables allowed in the pot. Those vegetarians who look at flesh eating from the standpoint of the animals that get eaten, join gladly with the animal-welfare societies in the celebration of "Be Kind to Animals Week" or of "World Day for Animals," the day dedicated to the memory of St. Francis of Assisi. They look with distress upon those other introspective brothers whose concern is only for their own dietary salvation. But the extensive literature of vegetarian cookery, recipes,

Continued on page 78

Marshes in the Treetops

by Marston Bates

My intimate acquaintance with bromeliads started while I was studying the epidemiology (natural history) of jungle yellow fever, which meant that I spent a great deal of time in the jungle, or as I would prefer to call it, the rain forest. It turned out to be a fascinating place. We tried to keep our eyes on the ball—on yellow fever—but this was hard because of the many distractions.

Among other things, we collected all the different kinds of mosquitoes we could find, whether or not it seemed likely that they were involved in yellow fever: we found nearly 150 species within a ten-mile radius of the laboratory. There are only 125 species of mosquitoes in all of North America north of the Rio Grande, which makes a nice demonstration of the richness of the tropical fauna. Mosquitoes are apt to be much more numerous in a New Jersey salt marsh or a Michigan bog than in a tropical forest; but in the north the swarms of mosquitoes will all be of one or two species, while in the tropics there are often many kinds flying—and biting—at the same time and place.

This multiplicity of kinds of mosquitoes reflects a multiplicity of kinds of breeding places. There are, of course, ponds, streams, puddles, swamps—the conventional mosquito habitats. But in the forest there are many other places where water accumulates, and wherever we could find water, we found some species of mosquito breeding. Most of the rot holes in trees held water, as did the bases of palm leaves that had fallen to the ground or the spathes of palm flowers. There were a number of rather special habitats, like the internodes of bamboo where some animal had made a hole permitting water to seep in, or the upright bracts of the flowers of *Heliconia*, a relative of the banana, which held 1 or 2 cc. of water—enough so that each flower was the home of several mosquito larvae. But the most extensive accumulation of water high in the forest canopy was in plants of the pineapple family, the Bromiliaceae.

The bromeliads form a large plant family with almost 2,000 species—all American except for one terrestrial species, *Pitcairnia feliciana*, found in 1938 in French Guinea (now the Republic of Guinea). How this lone species made its way into the African forest is anyone's guess; if bromeliads had been in Africa for any length of time, one would think that more than one species would have developed.

Most bromeliads are epiphytic; that is, they grow on the limbs or trunks of trees. They are not parasitic, since they get no sustenance from the host tree; they simply use it as a perch, a place to grow. Some, like the pineapple, are terrestrial, and a few grow on rocks, a habit that botanists call saxicolous.

Plants growing as epiphytes have water problems since they cannot reach the soil that provides moisture for terrestrial plants: even in the rain forest rain is intermittent, and there may be periods of many days without showers. As with desert plants, the problem has been solved by various methods of reducing transpiration and of storing water. In the case of bromeliads, a large proportion of the epiphytic species hold water in a "tank" formed by the closely appressed leaf bases: large plants may have five quarts of water or more. Dead leaves and other detritus accumulate in the tanks along with the water, making a rich mixture that is home for various aquatic animals.

The fauna of bromeliads and of other natural water containers has, it seems to me, been unduly neglected. Books on freshwater biology cover streams, lakes, ponds, marshes, and the like, but rarely mention small water accumulations. Even rot holes in trees get little attention, although they are common enough in the north and are breeding places for a number of insects, including several species of mosquitoes. The special tropical habitats, like the tanks of bromeliads, are ignored. For me they have the fascination that so often goes with the miniature.

One of the few detailed studies of the inhabitants of bromeliad tanks was made by Albert M. Laessle on the island of Jamaica (published in the issue of *Ecology* for July, 1961). As would be expected, he found numerous protozoans, and was able to identify fifteen species with some certainty. Several species of small worms were present, as well as small crustaceans. A peculiarity of the Jamaican bromeliad fauna is a special crab, *Metopaulias depressus*, that he found exclusively in these plants and only at elevations above 1,000 feet; he collected as many as thirty specimens from a single large bromeliad. Another species of crab has been reported from bromeliads in Brazil, but in this case the species occupies many other habitats and probably does not breed in the bromeliads.

Insects, understandably, are the most abundant inhabitants of bromeliad tanks. Laessle found a dragonfly and a damselfly breeding in Jamaican bromeliads; one species of water bug and six of water beetles; and seven species of mosquitoes as well as eight other kinds of flies. Two species of tree frogs breed in Jamaican bromeliads, and other kinds of tree frogs are often found hiding in the plants, although they do not breed there.

Two tropical American species of *Anopheles* breed in the tanks of bromeliads, and in Trinidad and southern Brazil they have created serious malaria problems in areas where the plants are particularly abundant. Concern about bromeliad malaria has led to some of the most

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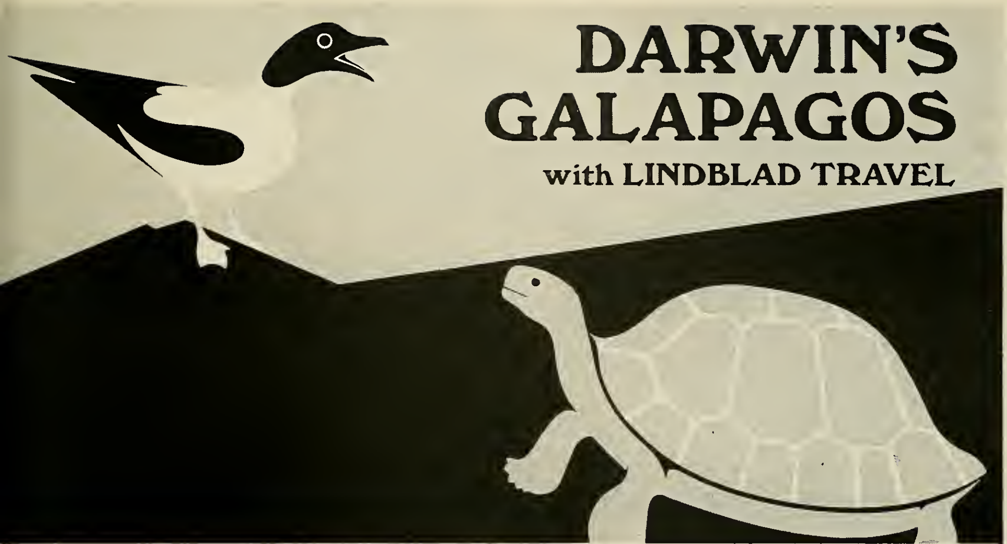

The GALAPAGOS ISLANDS are zoologically-speaking the best known group of islands in the world, for it was here that Charles Darwin first stumbled on his evolutionary theory. The islands are justly famous, too, for their stark beauty — they have been described as "a harsh Eden" — and the extraordinary variety of unfamiliar animals. Giant tortoises, land and marine iguanas, brightly-colored crabs, playful sea lions, three species of boobies, enormous frigate birds with their bright red throat pouches, gulls, terns, tropic birds, petrels, albatrosses, scurrying lava lizards, flightless cormorants, even penguins (on the equator), all jostle the visitor and amaze him by their almost unbelievable tameness. Nearly every creature on the islands is peculiar to the islands, and hence their names: "Galapagos hawk," "Galapagos snake," Galapagos penguin," etc. These volcanic islands, 600 miles out in the Pacific off Ecuador (to which they belong), are truly a paradise for naturalists. Washed by the clear blue waters of the Humboldt Current, which provides fish aplenty for the countless seabirds, they would be nearly everyone's ideal — were it not for the fact that few of them have any water, soil is thin and poor, cactus is plentiful, and communications with the mainland difficult. It is normally virtually impossible to see more than one or two islands without spending considerable time and money, and so it is a journey few have ever made.

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careful ecological and physiological study of the plants. Control has sometimes been attempted by cutting down trees near villages, but the careful use of herbicides is less drastic and more efficient.

The water and debris of the tanks nourish the bromeliads as well as the animal inhabitants. Special scales on the leaves (called epidermal trichomes) absorb water and nutrients, and the roots of the plants serve only to anchor them to the limbs and trunks of the host trees. In a few species axillary roots grow upward into the water and detritus held by the overlapping leaves.

Detritus often accumulates above the water level, and on the outside among the roots. This offers shelter to a considerable variety of nonaquatic animals, so that one can refer to the "terrarium" as well as the "aquarium" aspects of the bromeliad environment. I suspect that those cockroaches that plague our house and furnish food for frogs and lizards in my experimental rain forest arrived from Florida nestling in bromeliads.

Several species of stinging ants make nests among the roots—a symbiotic, or mutual aid, relationship, since the plant provides a home for the ants, which in turn protect the plant. Orchids and other epiphytes are also frequently inhabited by ants, making tree climbing in the tropical forest a hazardous experience.

The pineapple is, of course, the best-known of bromeliads. It was widely cultivated by the Indians of the American tropics, where it was encountered by Columbus in 1493 on the island of Guadeloupe. It was spread widely over the world by Spanish and Portuguese colonizers, and it is now grown almost everywhere in the tropics, even on remote Pacific islands. Curiously, the main horticultural varieties were developed early in the last century by English gardeners growing plants in glasshouses; commercial cultivation in England disappeared, however, when it became practical to ship fresh fruit from places like the Azores.

When I was a boy there were large pineapple plantations in southern Florida. These have since nearly vanished and now our pineapples mostly come from Hawaii, where they are an important element in the economy; the value of the 1959 crop, according to the *U.S. Census of Agriculture*, was over 38 million dollars.

Many bromeliads have long been grown as ornamentals in European greenhouses and conservatories. The flowers of some are spectacular, and almost all are colorful—mostly red, pink, lavender, or blue—the color being due to prominent bracts rather than to the petals themselves. With some species, the flowers last for only a few days, but with others the bracts remain colorful for months. Many species also have bright berries or variegated foliage.

Bromeliads have become increasingly popular as house plants in the United States. A Bromeliad Society was organized in 1950, with headquarters in California. The society publishes a bimonthly *Bulletin* with articles on bromeliad culture, on experiences in collecting bromeliads, on classification, and the like. The cover of each issue has a color photograph of some interesting member of the family.

Someday bromeliads may be as widely grown as orchids. They seem to me equally interesting and in some respects easier to maintain. Jack Kramer's book entitled *Bromeliads: The Colorful House Plants*, based largely on his experience with these plants in his Chicago apartment, demonstrates that it is not necessary to have a greenhouse. Bromeliads have not had nearly as much horticultural attention as have orchids, but a number of hybrids and showy cultivated varieties have been developed. They can be more easily grown from seeds than orchids, but this is still not a project to be undertaken lightly. Much care and patience are needed, and growth from seed to flower requires several years. Fortunately bromeliads freely produce offshoots or suckers (known as "pups" to bromeliad fanciers) so that vegetative propagation is no problem.

Most people grow even epiphytic bromeliads in pots, using much the same materials and conditions as for epiphytic orchids. It bothers me to see a plant that should be growing on the limb of a tree, growing in a pot, so I wire my own plants to pieces of branches or of tree fern trunks, which I hang from the ceiling of the greenhouse. In a few months the plants anchor themselves firmly with their roots and then present a much more natural appearance.

Sometimes bromeliads go for long periods without flowering, and vari-

ıs methods have been worked out r forcing bloom. Pineapples grown hothouses in the Azores are forced bloom at any desired time by keep-g the plants in an atmosphere of ick smoke for several days, made 7 burning straw or other material. his also works for epiphytic bro-ıeliads, but can hardly be recom-ıended for the living room. The gas hylene also induces blooming, and . M. Cathey, a horticulturist work-ıg in the Beltsville agricultural sta-on in Maryland, has worked out a ıethod of forcing flowers by en-losing plants for four days in a plas-c bag with slices of apple—the pples give off ethylene. One grower iscovered accidentally that the ımes from a pile of manure in his reenhouse caused an unusual num-ıer of bromeliads to flower, and sev-ral other gases have been found to ıe effective, including fumes from ıutomobile exhausts.

A number of bromeliads are na-ive to southern Florida, where they ıre commonly called air plants. Some ɔf these hold water in which mosqui-oes and other insects breed; small 'rogs and lizards are frequently 'ound hiding in these Florida plants, ɔut none is adapted to breeding here. The well-known Spanish moss ɔf Florida and the Gulf States is a ɔromeliad, classified by botanists as *Tillandsia usneoides*. The other spe-ɔies of *Tillandsia* have a more ortho-dox, pineapple-like appearance. The tiny flowers of Spanish moss, about a quarter of an inch in diameter, are rarely noticed.

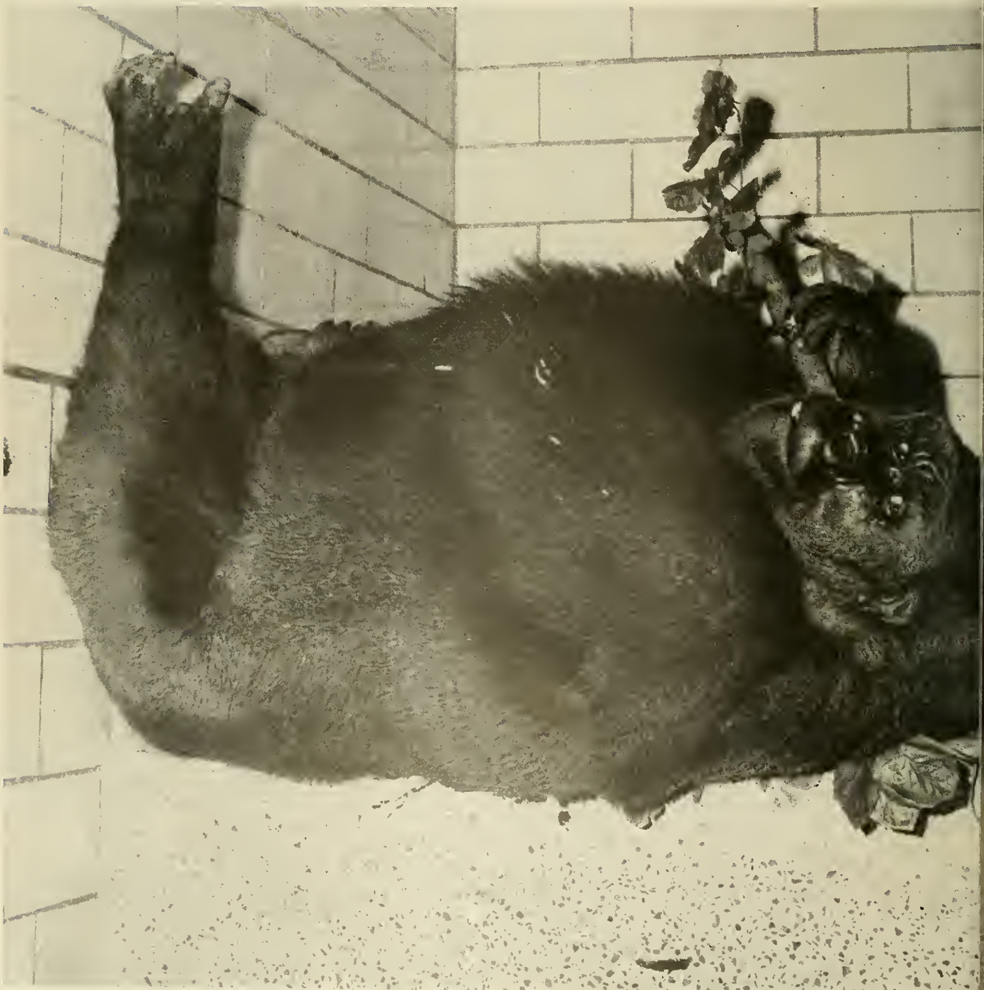
Spanish moss grows readily in a greenhouse, producing a nice, tropi-cal effect. I have been unable to get it established in my place, however, because the birds pull it apart to use as nesting material, the only plant damage that I can pin on the birds. The fiber has been popular as a stuff-ing for upholstery and mattresses. In the West Indies it is sometimes used as a styptic pad to stop bleeding. Dr. C. W. Mayo of the Mayo Clinic found that it was more absorbent than cot-ton, taking up "from six to ten times its dry weight in water." It seems, however, never to have found favor with physicians.

Except for the pineapple, then, bromeliads are not notably useful plants. But they are extremely inter-esting biologically, and they warrant much more attention than they have received from horticulturists.

The Zoo Story

by WILLIAM G. CONWAY

The zoological park extends the reality of the biosphere into the architectural badlands of the city limits



Virtually extinct in the wild, the Mongolian, or Przewalski's, horse, above, breeds successfully in zoos. Since gorillas destroy the more fragile habitat, they are often housed in tile-walled pens, left. Some zoos are replacing these with equally durable, but more natural, enclosures.

There are eight times as many known paintings by Rembrandt as there are whooping cranes and California condors together, and it is safe to say that more living Americans have seen the work of this seventeenth-century Dutch painter than one of these spectacular native birds. But rarities aside, how many people living in Chicago or New York have ever seen a wild otter, a fox, or an American elk? How many have seen a bullfrog, a box turtle, or a ruby-throated hummingbird? A proportionately decreasing number of Americans will ever see any wild animals outside of zoos. This is a bleak, unpleasant prospect. But it is difficult to dispute and has many implications; one is that the role and development of zoos are worth a new look.

In the crowded city the zoo provides an exceptionally diverse area within the relatively homogeneous municipal environment and introduces more living variety into the city habitat. It extends the reality of the biosphere into the unnatural architectural badlands of the city.

Last year zoos and aquariums (to save words, I will call them both zoos) recorded nearly 90,000,000 visits in the United States. This figure surpasses the attendance at any other kind of cultural institution and greatly exceeds the combined attendance recorded at all national baseball and football games.

It does not take forceful persuasion to get children (or adults) to visit the zoo. (In fact the zoo is one of the first places truant officers check for absent school children.) Few people go to the zoo to get educated; they go for fun. But there is no law that says education and recreation must be mutually exclusive. This is the advantage of visiting a zoo, for it is almost impossible there to miss the lessons we have to learn from wild animals.

One of the most significant roles of zoos is that of providing visitors with some feeling for the importance of wildlife protection. While there seems to be a growing awareness of the inherent beauty of wild creatures, it is surprising that the realization that many wildlife species are close to extinction has not yet fully penetrated the consciousness of modern societies. An interest in wildlife does not usually receive the social approbation, or confer upon its possessor the social status, accorded to a patron of the fine arts. A bronze stag by Barye is considered by many to be an esthetically compelling object while the stag itself is not. Although my own view may be overly biased, I suspect that an intellectual

involvement in the protection of wild animals may yet be recognized as the highest form of estheticism. In any event, a concern with the maintenance of a beauty that is not created by man is a highly civilized and altruistic form of artistic appreciation. William Beebe, when curator of birds at the Bronx Zoo, expressed it this way: "The beauty and genius of a work of art may be reconceived, though its first material expression be destroyed: a vanished harmony may yet again inspire the composer; but when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

Many of the endangered species that are listed by the International Union for Nature and Natural Resources are now being bred in zoos. The International Zoo Yearbook census records the 1967 breeding of 51 species of endangered mammals, 21 birds, and several reptiles and amphibians. Included are the births of fifteen orang-utans and the hatching of six Galápagos giant tortoises. Without captive collections, for instance, there would not be any Père David's deer or European wisent or Przewalski's horses. Several more birds would be almost extinct.

The stories of man's few captive wards among the long lists of animals that have become endangered in recent years are not as well known as they should be. The Père David's deer, for example, was evidently a resident of the plains of northeastern China. But it had probably been extinct there for more than a hundred years when the French missionary-scientist Père Armand David became the first Westerner to see them in 1865. He found a herd living within the walled Imperial Hunting Park near Peking. Beginning in 1869, a few of these great, grotesque deer began trickling into Europe's zoos and this proved to be the species' salvation for, in 1900, during the Boxer Rebellion, European soldiers slaughtered all those that remained within the Imperial Park. Although the fortunes of the European herd rose and fell as the continent was torn by World Wars I and II, there were 452 alive in 46 collections by 1967. A few had even been returned to

China as a gift from the London to the Peiping zoo.

The Mongolian, or Przewalski's, horse (last of the true wild horses) is now extremely rare if not extinct. The animal once ranged through southwestern Mongolia and northeastern Sinkiang. Present captive herds are descended from 28 animals collected during a special expedition commissioned by England's Duke of Bedford and sent to Mongolia by the famous German zoo enthusiast Carl Hagenbeck. Although collections at the Duke of Bedford's estate and elsewhere failed to maintain themselves, thriving herds were built up at the Munich and Prague zoos and were carried through the World Wars. In 1960, the International Przewalski Studbook, established to insure the purity of the wild animals, which interbreed readily with domestic horses, recorded 59 captive Przewalskis. The 1967 census records 147 specimens in thirty-five collections. The opportunity to view these endangered creatures, to see living representatives of species extinct, or nearly so, in the wild speaks well of the zoo's preservationist role.

Most biologists agree that national parks offer the best practical solution for preserving wild animals, but not all parks can be kept permanently inviolate. Outside pressures may change the ecosystems in even the largest parks, as witness the effects of water diversion at Florida's Everglades National Park. Even the most optimistic field conservationists point out that more animals are almost certain to be added to the extinct or vanishing lists within the next few decades. The hope is that at least a few of these animals will be tided over this period in man's history when he seems unable to con-

trol either his population or his devastating consumption or the pollution of all that surrounds him.

We would still have passenger pigeons and Carolina parakeets if zoo animal-management techniques had been up to their present level at the turn of the century. In fact. both species were bred in zoos a time or two; but neither received sufficient attention. It seems likely that the great auk, the dodo. the elephant bird. and the various moas could also have been maintained in captivity had remnants of their populations survived to the present. If they had been, I suspect they could now be reintroduced in reconstituted and managed parks in their homelands.

I am not suggesting that the zoo is an adequate substitute for wilderness or that zoo herds are a substitute for preserving animals in nature.

In an attempt to produce captive progeny, the London and Moscow zoos brought male, left, and female pandas together. A male gorilla, below, displays aggressively before his intended mate—typical behavior whenever these animals are joined for the first time.

It would be an ironic distortion of our purposes if the existence of endangered animals in zoos were used as an excuse to diminish the support needed to preserve their wild populations. But the zoo does seem an appropriate center for the promotion of conservation efforts. Until recently, "zoo" was a bad word to many conservationists, perhaps because of the feelings of some that zoos contribute to the decimation of wildlife or that confining an animal is cruel. Insofar as I can determine, zoos have not been a significant factor in the reduction of any wild species with the possible exception of the orang-utan. But even the orang suffered far more from hunting, habitat destruction, and collecting for pets, circuses. and special scientific purposes than from zoo collecting. Nevertheless, the American Association of Zoological Parks and Aquariums became so concerned over the deteriorating condition of the orang-utan population that in 1962 they began self-imposed boycotts of the big primate. An AAZPA committee, headed by John Perry of Washington's National Zoo, watches over the trade and attempts to head off improper importations. The Wild Animal Propagation Trust has set up another committee, composed of zoo administrators, that strives to increase captive breeding of orangs. Males of proved potency are now shipped around the country to formally arranged assignations with ladies of their kind in one zoo after another. The zoo association has also voted boycotts of other species that, it is felt, zoo collecting might endanger.

However, the zoo trade is but a fraction of one per cent of the live animal business. In 1967, wildlife importations into the United States alone (according to a Department of Interior news release) included 74,304 mammals (of which 62.526 were primates largely for laboratory use), 203,189 birds (not including canaries, parrots, or parakeets), 405,134 reptiles, 137,697 amphibians, and 27,759,332 fish. By contrast, the total number of all the vertebrates in all the zoos in the world is approximately 500,000 and many of these are captive bred.

If it is contended that any confinement or restriction of freedom

is cruel, then zoos may be justly condemned. But in a similar way schools, church classes, social stratification, and lack of money are also cruel. It seems to me that captive exhibition per se is not cruel, but that poor captive exhibition may be. It would be as foolish to deny that there are poor zoo exhibits, ill-suited to the needs of their subjects and those of their viewers, as it would be to deny that there are poor schools, hospitals, and churches. Every zoo in the world has bad cages, but there is also an increasing and continuing effort to improve them.

Poor exhibition of captive animals is very difficult to define, for there are so many specialized creatures with so many different requirements. Further, the human concept of cruelty is sufficiently ambivalent as to defy rational description. I happen to be especially interested in frogs, but no matter how badly they are cared for in pet shops or zoos, I have never heard anyone complain about their treatment. One must not beat a dog, a cat, or a horse, but we complain relatively little about the comparable (if necessary) stress wild monkeys or rats receive in the normal course of laboratory study. We complain about a zoo birdcage as being too small to allow its occupants to migrate, then go home and whisper sweet nothings to our pet parrots or myna birds confined in cages where they can scarcely open their wings. No one thinks anything of allowing some freshly caught bass or trout to flop its life out on the bank or in the creel, but both the local police and fire departments will respond to a call to rescue a bird-hunting cat stuck in a tree. If zoos were to provide whole carcasses for their big cats and eagles to feed upon, someone would probably stop to complain about this implied cruelty on his way to pick up a steak at the butcher shop.

Dacca, the Bronx Zoo's famous tigress, was bred in the zoo, lived there for 20 years while producing 32 fine cubs, and spent her entire life in an indoor cage that measured 15 by 16 feet and an outdoor cage approximately 20 by 25 feet. Frankly, I think these cages are too small, too homogenous, and too unattractive to be good exhibition from the standpoint of animal well-being or visitor enjoyment and education. But Dacca's good temperament, near world-record longevity, and marvelous breeding record, as well as her large following among zoogoers and staff members, belies my opinion. Her cage was larger than many other tiger cages, where big cats have also done well and smaller than many where tigers have done less well.

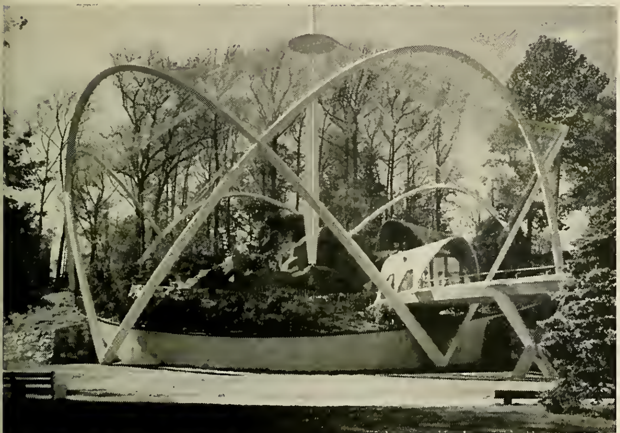
Few people realize that the expression "free as a bird" is generally a misnomer. For wild creatures are captives of their requirements, their adaptations, and their environment. In the wild, a prairie chicken needs prairie or something very close to it. He is limited there by his food and nesting requirements and by his specialized defenses against predators. When his prairie "cage" is destroyed, he dies out with it whether or not a hunter ever fires a shot at him. It is curious that no one ever thinks of habitat destruction in terms of cruelty to animals.

When wild animals breed consistently, rear their young, and attain good longevity, I think we may infer that their confinement, even though it may not meet our anthropomorphic precepts of optimum space, sunshine, or opportunity to chase and kill prey, is not cruel. However, there are numbers of local and roadside menageries, pet shops, and animal-dealer compounds where animals are so crowded, so poorly housed, or so badly cared for that captivity is ever afterward associated in the viewer's mind with cruelty. National laws and standards must be promulgated to eliminate this wild animal suffering. It is disgraceful that a people that lavishes so much attention upon the well-being of dogs and cats, pays so little to the plight of delicate wild animals. In good zoos, captivity is rarely cruel even if not ideal.

The zoo profession seems to be growing constantly more critical of its own past efforts in exhibition and animal maintenance. Until recently, many zoos competed in a sort of species race, each foolishly attempting to have more kinds of "mugwumps" or "fiddlesaurs" than their competitors. The large number of cages dictated that each enclosure be

small. Often only one representative of a species was shown so that more room could be made for showing more species. Social groups and mixed displays, except among hoofed animals, were not common. The zoo merely tried to show its visitors what kinds of animals there were rather than demonstrate where or how they live. Relatively few animals were bred. I have been told that at least one of my predecessors thought breeding animals in a zoo a little bit questionable if not indecent.

Attempts at providing "natural habitat" exhibits, using a simulated section of some portion of the animals' home area, are still relatively rare—and for a good reason. Imagine trying to prepare a museum-type habitat for a living family of gorillas. Live plants and trees and anything else that could be destroyed would be out of the question. This helps explain why we often house such animals in tile-walled cages that look like giant bathrooms.



The modern walk-in aviary at Washington's National Zoological Park is among the newer structures being used in zoos. European wisent, left, are displayed in a natural habitat in East Berlin.

If a zoo animal is to be seen, there must be some restrictions on display space, especially if its lighting, temperature, and humidity must be controlled. And, like man, wild creatures are subject to myriad diseases. Sanitation is a necessity: cages must be cleanable. Yet the "lavatory type" of exhibit so distorts the impression of the animal, its adaptations, and its place in nature that it proves unfair to the zoogoer. A group of gorillas sitting in one of these tile-walled monstrosities is scarcely more meaningful, as a wild animal exhibit, than a picture window on a community privy, and gives a poor idea of what a gorilla looks like in the wild. The animal should be seen, if possible, against a suggestion of the forest to which evolution has adapted him, not disenfranchised in tile and concrete.

Recent developments at Tucson's Arizona-Sonora Desert Museum and at the Bronx Zoo show that indestructible, cleanable, and realistic zoo habitats are within reach. A fiberglass jungle-floor exhibit in the Bronx Zoo's monkey house has withstood the wear and tear of a large and prolific family of mandrill baboons for more than three years. Although the cage is too small to be ideal, its fiberglass trees and simulated lichen-covered rocks give a far more meaningful view of the baboon than a tile-wall cage could ever essay. In bird and reptile exhibits, live plants and even open-fronted displays and "walk-in" cages are increasingly better employed in several zoos. The Bronx Zoo's aquatic bird exhibit has four open-fronted displays where only low railings separate viewer and viewee. The birds seem to know that the best place to be is in their exhibit where there are plants, water, and food and which is usually kept lighter than the public space. Because some of the zoo's less disciplined visitors might get the same idea, closed-circuit TV monitors viewers at such installations.

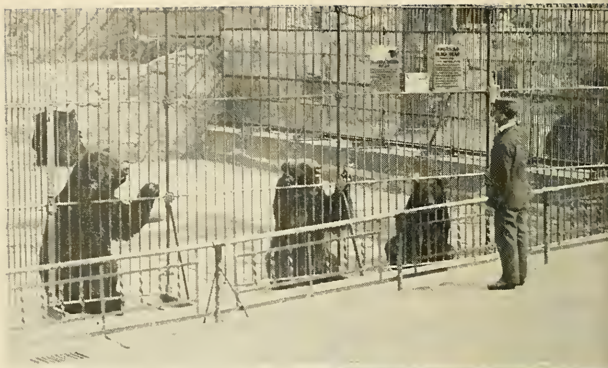
Traditional presentations of animals, in related groups, are now being supplemented by thematic presentations embracing ecology, zoogeography, and even animal behavior. A fine example of an innovation in behavioral exhibits is found in recent zoo expositions of nocturnal animals. Until 1960, when the Bronx Zoo's Joseph Davis began experimenting with red light, few zoos had attempted to solve the problem of exhibiting that great proportion of the world's mammals that sleep all day and become active at night. Generally such animals as bush babies and flying squirrels were seen only as lumps of unmoving fur that evidently lacked habits and even faces. But by brightly lighting these exhibits with white light at night and

with red light during the zoo visiting day, the activity cycles of these creatures were successfully reversed. It is a pleasure to look at a bush baby actively looking back in many zoos today. In the spring the Bronx Zoo will open a whole new building, entitled the World of Darkness, based upon this activity reversal scheme.

The actual management of wild animals in zoos is undergoing intense study, as is their exhibition. The bond between the animal keeper and his charge is an especially important one. Effects of reduced behavioral opportunities in captive animals and the importance of sociality are also receiving special attention. The need to maintain animals in groups is underlined by many little-understood observations: that cows and chickens in groups eat more than they do as individuals; that tadpoles whose tails have been amputated regenerate them more rapidly when in a group; that some animals, when reared together, may be slow to breed. Sophisticated curators are now exploring the problems incurred by groupings of species whose innate patterns of dominance and aggression are not accommodated in a traditional exhibit. We have learned that species reproductively dependent upon innate and complex courtship programs cannot be expected to reproduce consistently in captive habitats that do not provide the special tools and environmental cues necessary for their breeding behavior. We are attempting to remedy these situations. A bird that needs a vertical twig for a particular part of his courtship, a mammal that needs a scent post and a burrow, or a reptile that requires cyclical temperature change are more likely to reproduce when the proper ecological furniture is provided.

Captive propagation of many species is now so routine that there may soon be no way to dispose of the progeny. Many zoos have stopped maintaining pairs of hippopotamuses for this reason. Lions and some species of deer and antelope are beginning to reproduce so freely in captivity that they have become giveaways in some collections.

The food of wild animals in captivity has also received a great deal



At right, Kodiak bears are now contained within barless enclosures at the Bronx Zoo. Traditional bear cages are shown above.

of attention. Complex formulas—based upon information available for domestic livestock, modified on the basis of our understanding of the animal's wild diet, and then tested by trial and error—have been developed, which appear satisfactory for most zoo animals. Less emphasis is being placed upon forcing the animal to adapt to zoo conditions and more upon adapting the conditions to the animals.

Although space limitations are ever present in the zoo picture, many animals react to their enclosures as places of security to which they will willingly return when they have been properly cared for. When I was with the St. Louis Zoo, three goose-sized horned screamers grew new feathers on their clipped wings, flew off, and soared over the zoo each day about noon for nearly two weeks. It was only when they made the error of returning to their enclosure while a keeper was looking for them that it was realized they were working for the zoo only on a part-time basis. When a storm blew out a large glass window in an exhibit housing a pair of Himalayan red-billed blue magpies at the Bronx Zoo, the frightened birds flew out and disappeared. The following day when the winds had died down, they were back in their cage, and the extent of their travels between times is still unknown.

The need for added knowledge of the wild-animal world, combined with the availability of wild animals in city zoos near universities and research centers, points to the zoo's developing role in research. Although surgical manipulation of these animals is rarely practiced, behavioral observation and experimentation can be accomplished with unparalleled intimacy. Major research efforts now under way in several American and European zoos and aquariums, including those in San Diego, London, Washington, Frankfurt, Philadelphia, and in New York, the Aquarium and Bronx Zoo, are proving especially useful as a supplement to field work. It is much easier and more tactful to determine a tiger's gestation period in the zoo than in the wild. Comparative studies are also appropriate. How else could an investigator interested in large, flightless birds compare the emus and cassowaries of Australia and New Guinea, Africa's ostriches, and South America's rheas in any direct way? Although the development of research programs has lagged in many zoos, it seems safe to predict that zoo research efforts will become at least as significant as their programs in conservation and education.

Zoos are symbolic outposts of living wildlife; they lend an urgency and reality to efforts to preserve the quality of our environment at a time when its destruction—through overpopulation, exploitation, and pollution—is finally in sight. If nothing else, they will insure that at least as many people see elephants and whooping cranes as Rembrandts.

Photographs by LEE BOLTIN

COLORS FROM THE

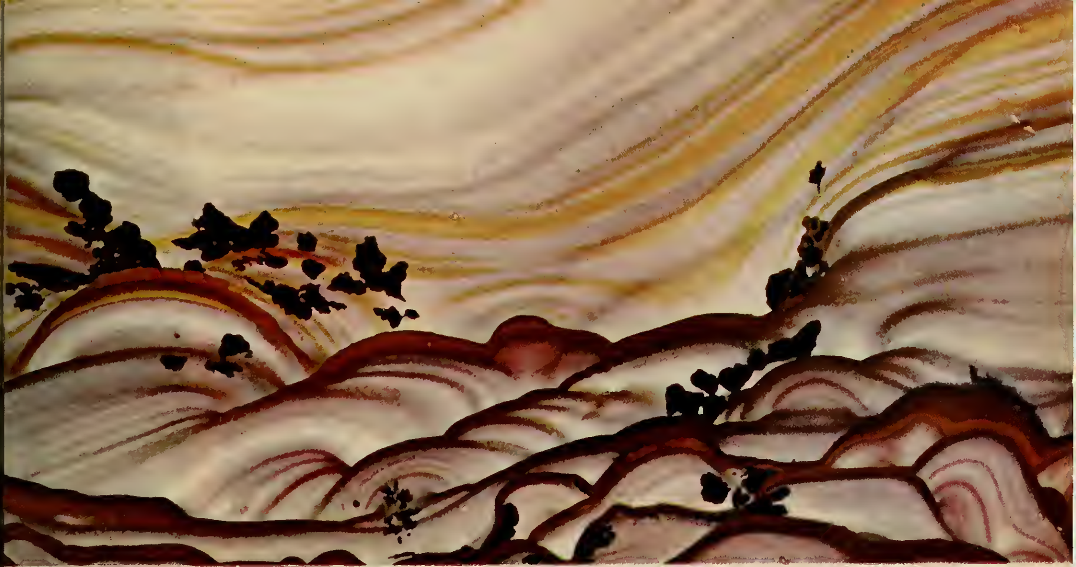
The dullest valley or barest mountaintop may conceal beneath its surface minerals of exotic color and sculptured form. Created by events spanning billions of years of geologic history, the brilliantly hued specimens on these pages are only a sampling of the 2,000 or so mineral species that make up the earth's crust.

Ever since the earth was born from the dust and gas of space, minerals have been forming. Some occurred when magma cooled under varying conditions; others resulted from huge uplifts and faults in our ever-changing rocky crust. Later, rains and other erosive forces laid down layers of sediment that compressed over the centuries under unimaginable pressure, adding to the great variety of the earth's mineral wealth.

Perhaps the most extraordinary result of these mineral-forming processes is esthetic—the natural beauty of mineral colors, represented here in a selection of photographs from *The Mineral Kingdom,* by Paul Desautels. The seemingly infinite combinations may confuse the amateur collector. Color is sometimes useful in identifying minerals, but it can by no means be depended on, for nature often imparts a different hue to various specimens of the same mineral. Impurities also play some deceiving tricks. The common mineral quartz, for example, is transparent and colorless in its pure state. But its numerous varieties range from grains of sand on ocean beaches, to the valuable purple amethyst, to the beautiful, milk-colored, baroque formation on the facing page. This is an agate from Mexico, an extremely fine-grained quartz. Its engaging form and the clarity and vibrance of its color are typical of the valued specimens that inspire mineralogist and layman alike.

UNDERGROUND

Three phenomena—inclusion, iridescence, and twinning—are shown belo
at left, sand inclusions in azurite; directly below, iridescence in a fossil she
and at bottom, twinned tetrahedrite with chalcopyri
Looking like landscape paintings, the specimens on the facing pa
are actually fine-grained minerals whose patterns are caused by impuriti
trapped during formation. Top, a polished sample of jasper from Orego
Bottom, sedimentary agate from Arizon



Slender, radiating crystals of millerite in iron ore, below, from defunct iron mine in Antwerp, New York. Other minerals shown here are gems—minerals that combine beauty, rarity, and durability. Amethyst crystals at right are in an agate-rimmed geode from Rio Grande do Sul, Brazil. At far right, gem tourmaline from Minas Gerais, Brazil. At bottom, precious opal, although not as durable as most gemstones, is a favorite because of its lustrous play of colors.

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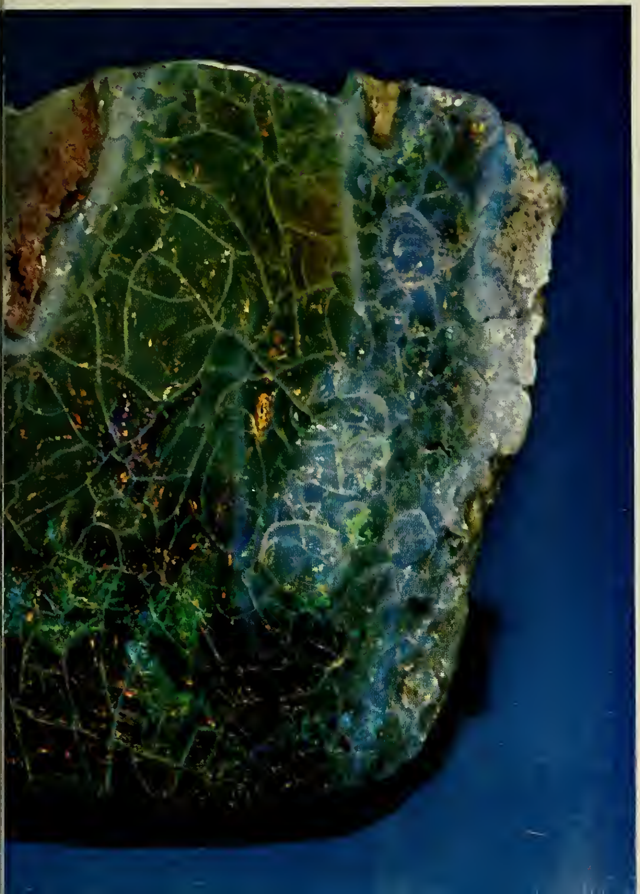
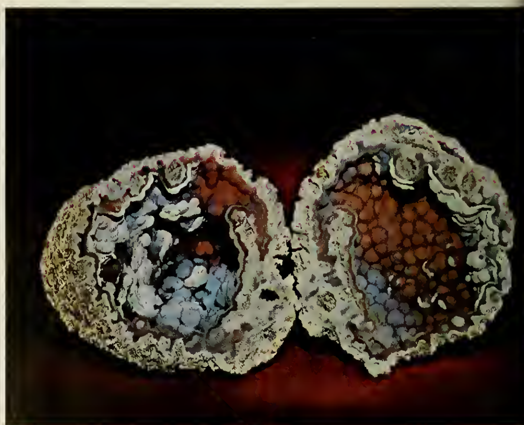


Agates, below left, are formed by the seepage of ground water through rock cavities. Another product of the interaction of water and rock is the stalactite; directly below, rhodochrosite stalactites from Argentina have been cross-sectioned. At bottom, coral replaced by chalcedony (a process identical to the replacement of wood by jasper in petrified wood). On facing page, fine needles cast a soft glow in sample of wavellite from Germany.



LIFE IN A HOT-WATER BASIN

Since the hot springs at Yellow-
tone National Park are fed by water rom deep in the earth, they do not top flowing when winter comes; in act, their water temperatures re- nain constant throughout the year. Even the temperatures of their out- low channels do not drop greatly n winter. Consequently, each steam ent and spring is clearly revealed y its long plume of steam that rises hrough the cold, crisp air and is harply outlined against the blue sky.

After doing biological research at Yellowstone for a number of sum- mers, we were able to spend some time there in the winter. Transporta- tion problems formerly could have been a drawback. But with modern snow vehicles, it was easy to travel from our laboratory in town to the geyser basins to search for the life forms that inhabit this hot spring environment.

Such a situation is rife with in- formation for the ecology-minded biologist. The hot water of the ther- mal areas creates a whole range of tropical and supertropical environ- ments. Each hot spring—the spring itself and its immediate area—con- stitutes a little island where life is not dormant even though it is closely surrounded by the cold and snow of a Rocky Mountain winter. Indeed, we have found that in several aspects the springs are richer with life in winter than in summer.

But, winter or summer, life at the hot springs shows extraordinary ca- pabilities. Some bacteria, for exam- ple, thrive here in boiling water. On the other hand, there is the ephydrid fly that wears an air bubble to keep it dry and presumably cool when it walks completely underwater to feed on the matlike growth of algae and bacteria in the effluent channels. Then too, there is the range of bril- liant, changing colors provided by these microorganisms.

The colors vary with the type of organic growth favored under differ- ing conditions: depth of water, its temperature, and the season itself. As we will see later, these variables explain why the striking yellows and oranges, seen under some con- ditions of temperature and light, deepen under other conditions to the dark green that shows algae are now monopolizing the visible color with their distinctive pigments, chlorophyll and phycocyanin.

Nowhere else in the world are hot springs so predominant as at Yellow- stone. Geysers, such as Old Faithful, account for only a small fraction of the park's attractions; there are more than 10,000 hot springs, steam vents, mud pots, and other thermal features. Moreover, Yellowstone is unique, as its hot springs are virtu- ally free from human disturbance.

There are many reasons why a biologist might wish to study life in hot springs, aside from a natural interest in the peculiar and unusual. Most of the earth's surface has a low temperature, the worldwide average being 12°C. (54°F.). Yet, geolo- gists and astronomers tell us that at one time it was much hotter. Did life exist in those much hotter times? The presence of organisms in hot springs today tells us that, at least in principle, life was possible in earlier times. The evolutionist has always been interested in life in ex- treme environments, because the success of organisms in such envi- ronments reveals the degree to which evolution can be pushed.

Also, the springs contribute to research in modern ecology. They provide admirable ecosystems for study because at higher tempera- tures the variety of species is greatly reduced; and in the most extreme environments, an ecological investi- gation is frequently simplified by the presence of only one kind of or- ganism. With fewer species, it is easier to define clearly the nature of competition and co-operation be- tween organisms; easier also to dis- cern aspects of the food web. In ad- dition, the relative constancy of the springs eliminates the need to make allowances for the large, seasonal environmental changes that compli- cate the picture in most other habitats.

Let us concentrate on a single, flowing hot spring, such as is found in Yellowstone Park's main geyser basins. The temperature of the source of our typical spring may be between 92° and 93° C. (about 200° F.), the temperature at which water boils at the altitude of Yellow- stone. The outflow from this spring is often confined to a single channel, perhaps two to three feet wide and six inches deep. As the effluent moves away from the source, it cools. If the flow rate and temperature of the source remain constant, the tempera- ture at a given location along the out- flow channel will also remain rela- tively constant, being affected only in a minor way by weather.

Living organisms develop along the bottom of this channel. Since all of them are exposed to the same amount of sunlight and to water of the same chemical composition, the principle variable is temperature. Thus, we have an outdoor laboratory where we can study the biological and biochemical characteristics of various organisms at different tem- peratures.

If we examine the organisms col- lected from the channel of our typi- cal hot spring, we can discern two patterns of species composition. The

HOT SPRINGS IN A TYPICAL GEYSER AREA AT YELLOWSTONE PARK CORRESPOND TO SMALL ISLANDS THAT PROVIDE INTRIGUING LIFE FORMS WITH A RANGE OF TROPICAL ENVIRONMENTS, EVEN IN THE WINTER SEASON.

BY THOMAS D. AND M. LOUISE BROCK

first pattern is that of the highest temperatures at which we find various taxonomic groups of organisms. These upper thermal limits, as we observe them in Yellowstone or as they are reported by others, are shown on the opposite page.

From this illustration we can see that there are distinct upper temperature limits for the different groups, and that the simpler organisms can grow at higher temperatures than the more complex organisms.

One of the discoveries most surprising to us is the presence and active growth of bacteria in boiling water. At first it was hard to believe that the bacteria we saw were really growing; the highest temperatures at which bacteria had previously been reported to grow were in the 70°C. range (160°F.). Our recent research has shown that not only are these bacteria growing there but that the growth rates are surprisingly fast. Using a simple technique that we devised for measuring growth rates of microorganisms directly in nature, we have determined that it takes between three and ten hours for a bacterial cell to increase in size and divide into two cells, depending on which hot spring we were studying.

The blue-green algae demonstrated especially well the existence of an upper thermal limit for a taxonomic group. Since these organisms are strongly pigmented, their position in the effluent chan-

nels is easily seen. In many such channels the area covered by algae takes the shape of a characteristic V, its edges delineating the maximum temperature at which the organisms can grow, 73°–75°C. (163°–167°F.). The V results because the water is hotter in the center of the channel than at the sides. Such a V for the algae is shown best at springs in which a relatively constant flow rate and temperature maintain a stable temperature gradient.

The second general pattern discerned when organisms from different temperatures along the gradient are examined is the diversity that exists within a single taxonomic group. Usually only a single species is present at the upper thermal limit for a group of closely related species. As temperature drops, more species can develop; this diversity reaches a peak, then declines as the water becomes cooler. This means that the single species found at the upper thermal limit has no competition from closely related forms. Is it possible that this species is not really optimally adapted to its habitat but is able to colonize this niche only because no other organisms can replace it?

We examined this question of adaptation by using blue-green algae found at the upper thermal limit and studying the effect of temperature on their rate of photosynthesis as measured with radioactive carbon dioxide. The answer was clear-cut. The algal species at the upper thermal limit was indeed optimally adapted to the temperature at which it was found: it photosynthesized less well at temperatures either above or below that point. In fact, the algal species at various temperatures down the thermal gradient were all optimally adapted to the temperatures at which they were found. These results and others show that an equilibrium develops along the effluent channel; the algae and other organisms at each place being those best adapted to the temperature there.

One of the most striking aspects of such a channel is the variation of brilliant colors imparted to it by the microorganisms. We have already noted that the colors vary with the season of the year, the depth of water in the channel, and the temperature of the water. We are often asked for more details about the color changes.

First, any colors we see are the result of two things: the kinds of pigments and their relative concentrations. Imparting color to the blue-green algae are at least three kinds of pigments: chlorophyll, phycocyanin, and carotenoids. Chlorophyll, of course, is green; phycocyanin, related to some of the chemicals found in animal bile, is blue; and carotenoids, which are similar to the pigment in carrots, are yellow or orange.

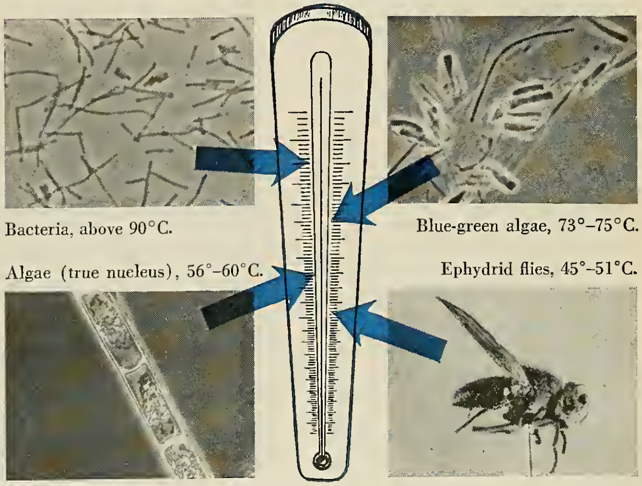
The chlorophyll and phycocyanin content of algae is affected greatly by the intensity of sunlight. This content decreases in bright light and increases in dim light. The carotenoid content, however, is not greatly affected by light intensity.

The color of the algae at the upper temperature limit is usually yellow or orange. This is due to two factors: (1) at these high temperatures, because the development of algae is very sparse, they form mats that are thin and absorb very little light; (2) in the intense sunlight at the altitude of Yellowstone, the algae reduce their chlorophyll and phycocyanin content to a low level, so that the carotenoids predominate.

Farther along the channel, where the water temperature is lower, the algae are able to grow better and form thicker mats. In such mats the

'n winter: White Dome Geyser, top, lominates its thermal area; Mushroom Spring, left, is used by a multitude of life forms; below, characteristic V-formation of algae grows in overflow stream from Columbia Spring.

UPPER THERMAL LIMITS FOR FOUR TYPICAL ORGANISMS



algal cells underneath are shaded by those on the surface. Since they receive less light, they produce more chlorophyll and phycocyanin. Thus the color of the mat deepens and becomes greener. But farther down in these thicker mats, where light does not penetrate, the algae cannot grow at all. Here only orange-colored bacteria can grow. Thus the green surface layer is underlaid by an orange layer, and the net effect is a greenish-orange color. The color response to changing light intensities is rapid. If a series of cloudy days occurs during midsummer, the algae will become noticeably darker green, because of the increased chlorophyll and phycocyanin.

Seasonal changes must also be considered. In winter, shorter and cloudier days predominate, and the algal mats, even at the upper temperatures, are always dark green.

However, even in the midst of a Yellowstone winter, there is always enough light to insure algal growth throughout the whole temperature range. This contrasts with hot spring areas in the Arctic, where algae cannot grow in the winter because of insufficient light. In Iceland, which is just below the Arctic Circle, the light intensity in winter is so low that the algae cannot grow as fast as they are washed away by the flowing water, and they disappear from the hot springs. When spring arrives, they begin to recolonize their habitats, and by June the algal mats are completely restored, only to disappear again the following winter. We have duplicated Icelandic conditions in Yellowstone by covering sections of the algal mat with black covers. Within two to three weeks the algae have virtually disappeared from the covered areas. If the cover is then removed, the algae return to essentially normal in about two months.

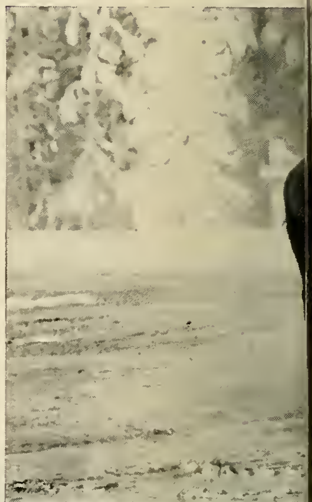
The ability of hot spring algae to adapt to changing conditions is seen even more dramatically after a natural catastrophe has eliminated them from a very large area. At a spring that we have been studying intensively for three years a violent hailstorm completely stripped away the algae in the upper temperature range. Within a week there was visible algal growth, and within a month about half of the equilibrium concentration of algae had returned. Within five months everything was back to normal. If we had not actually seen the effects of the hailstorm, we would not have known it had happened.

These observations show the immense capacity the algal ecosystems have for repairing themselves. Such repair mechanisms are occurring all the time to counteract minor damages. Buffalo and elk frequently cross the thermal areas and their hooves cause destruction of the algal mats. The footprints they leave do not remain long before new growth has obliterated them.

The animals seen living in the hot springs at temperatures below 50°C. (122°F.) include protozoans, arthropods, nematodes, crustaceans, and mollusks, but the most common and most obvious are flies of the family Ephydridae. These flies are found in hot springs throughout the world. Even a hot spring at 15,000 feet in the Himalayas is reported to have them. That they eat hot spring algae was suggested by the Danish zoologist Tuxen, who studied insects in Iceland's hot springs.

We have confirmed and extended Tuxen's observations. By dissecting ephydrid larvae and adults, we showed that their intestinal tracts were full of hot spring microorganisms, and a microscopic examination of both larval and adult excrement revealed it was composed mostly of algal remains. We have also shown directly by radioactive-tagging experiments that the larval and adult forms eat algae and bacteria.

There are a number of species of



Variety of warmth lovers: buffalo enjoys the steamy waters; the ephydrid flies feed on algae and, below, use algal mats for incubating eggs; a vascular plant, right, flowers in the warm, humid microclimate.

ɔhydrid flies, many of which are ;sociated with extreme environ-ents. The fly found in such large asses at Great Salt Lake is a spe-es of the genus *Ephydra*, whereas nother genus, *Psilopa*, is found at etroleum pools. The ephydrid fly udied by Tuxen in Iceland was of e genus *Scatella*. Yellowstone has everal species of ephydrids, and al-ıough all inhabit hot springs, each as a different kind of habitat. One y, *Paracoenia turbida*, is found pri-ıarily in alkaline hot springs where ıirly good water flow favors the evelopment of very thick algal mats. When laying eggs, this species pokes them down into the mat, so that only the tail of the egg can be seen on the surface. White larvae hatch from the white eggs and feed voraciously on the mat, into which they burrow deeply. They usually pupate near the bottom of the mat. The time for the complete developmental cycle, from egg to adult, is less than two weeks.

The other species we have studied in Yellowstone is *Ephydra brusei*. This species is found primarily at alkaline springs where the outflow leaves through broad, thin channels. In such channels, the algal mat is

thinner and harder, lacking the soft, spongy texture of the mat where *Paracoenia* lives. At a temperature of about 25°C. (77°F.) *E. brusei* lays pink eggs just above the water surface on twigs, pieces of rock, or portions of uplifted mat, usually in areas where moisture is actively condensing and the humidity is high. The eggs of this species do not have tails, but the larvae have appendages called prolegs, which make it easy for the newly hatched larvae to creep off the exposed surface and onto the algal mat.

Interestingly, the pink eggs of *E. brusei* and the large clusters of these flies at egg-laying times are more commonly seen at the springs in winter than summer. We think this is because *E. brusei* lays eggs only in a habitat where steam is continually condensing. In winter, the cold temperatures ensure good steam condensation, whereas in the summer, moisture evaporates quickly in the warm, dry air. In contrast, *P. turbida*, which pokes its eggs into an algal mat saturated with water, lays eggs throughout the year and is just as common in summer as winter.

One of the interesting features of ephydrid behavior is how closely the flies remain associated with the surface of the hot spring areas. If a swarm of flies is disturbed, they rise only a few inches, then quickly descend again. Thus the investigator working near a swarm of them is never troubled with flies lighting on him. It is fascinating to watch an adult ephydrid, kept dry by its air bubble, go underwater to feed on an algal colony. Possibly the bubble also provides insulation, permitting the fly to feed in water somewhat hotter than it could otherwise tolerate. Even when they are not totally immersed, the adult flies can often be seen walking about and feeding on surfaces hotter than they can endure in an immature stage; apparently this is because such a small portion of the adult fly is in contact with the hot area. Although the temperature of the surface water may be high, the temperature of the air above it, surrounding the fly, is much cooler.

A variety of animals prey on or parasitize the ephydrid flies. Among them are flies of the family Dolichopodidae, found most commonly on the mats that contain *P. turbida*; there they can be seen pulling up and eating the eggs and larvae. Although the dolichopodid flies probably do not eat adult ephydrids, there are a number of other predators that do.

Spiders are very common at the edges of the hot springs, and we have often seen them scamper out onto the mat, catch an adult ephydrid, and run back to the shore and eat it. Spiders also construct webs across those hot spring channels that have high banks; ephydrid flies could easily become trapped in these webs. Another predator seen frequently around the hot springs is the dragon-

fly, which patrols the banks of effluent channels and even flies across hot, steaming pools. Occasionally one descends too close to the surface of a hot pool, becomes wetted, and dies almost instantly.

Of the larger predators on hot spring insects, the most common is the killdeer, a bird that lays its eggs on the gravel-like soil in the vicinity of hot springs. Virtually every thermal area of Yellowstone has its complement of killdeer, and we have frequently seen them catching and eating insects while walking on the algal mats in areas of relatively cooler water.

Finally, the ephydrids are extensively parasitized by red aquatic mites, probably of the genus *Partnuniella*. The larval form of this mite is seen on most of the adult ephydrid and dolichopodid flies. When a fly alights, a mite larva can quickly attach to it, and move around until it reaches its favored spot, somewhere on the thorax. After engorging, it drops off into the water, where it changes into an adult. The red mite is also a predator of the pink eggs of *E. brusei*.

The banks of the hot spring channels also provide a habitat in which certain higher plants grow luxuriantly. The most common is the beautiful, yellow-flowered *Mimulus guttatus* var. *thermalis*, or monkey flower. At Yellowstone this plant is found exclusively in thermal areas, growing, not in the waters, but on the moist, steam-bathed banks. Snow does not accumulate along the edges of the hot spring channels, and the monkey flower finds the warm, humid microclimate of the banks an excellent year-round habitat.

This plant is especially interesting because, unlike most perennial plants in temperate regions, it grows throughout the winter. However, the winter growth is a low, compact rosette form that undergoes reproduction by the runner method. In early spring, the low rosette changes to a longer-stemmed form: it is in this form that flowering occurs. Flowering is profuse by late May and continues through the summer. We assume that the rosette form is a necessary adaptation to the warm winter microclimate that extends only a few inches above the

Yellowstone: undefiled landscape, left, shows steam rising in a thermal basin from various active sources such as the one below.

ground. In the spring and early summer, when the weather is warmer, the plant can extend its stems and leaves higher into the air, and flowering can then occur.

Among the few other vascular plants found around hot springs are the grass *Panicum thermale* and the common cattail, *Typha latifolia*. At temperatures above 40°C. (104°F.) vascular plants are virtually nonexistent. This temperature seems to be the upper limit at which they can continuously reproduce.

There is much more we would like to learn. The upper temperature for life as we know it, flora or fauna, has not yet been defined. The microorganisms we find at hot springs—are they relicts of primordial forms of life? Such fascinating challenges require satisfactory field conditions for proper research. Happily, no swimming pools, health spas, or inhalatoriums exist at Yellowstone to capture and alter the flow of its hot springs, no geothermal power plants have been constructed to harness the enormous underground thermal energy. And, if we can trust the American people, we anticipate that no such disturbances will occur in the future.

SKY REPORTER

OUR GALACTIC MAGNET Eleven years after the technique was first suggested, a radio astronomer has succeeded in measuring the intersteller magnetic field in our own Milky Way Galaxy. The force is 50,000 times weaker than the earth's familiar magnetic field that orients our compasses, but still strong enough to play an important role in the dynamics of our 100-billion-star home.

Polarization of radio and light waves from distant stars led astronomers to conclude years ago that the intersteller magnetic field existed. Measuring it was another matter. At the National Radio Astronomy Observatory in Green Bank, West Virginia, Gerrit L. Verschuur has now succeeded by using the Zeeman effect.

Peter Zeeman was a Dutch physicist who first noticed that the spectral lines at a given wavelength of radio or light waves were split into several components by a magnetic field. The severity of splitting gives the strength of the magnetic field.

Verschuur reported in *Physical Review Letters* that he found the greatest strength in the Perseus spiral arm of our Galaxy in the direction of the radio source Cassiopeia A. No magnetic fields of this strength have been found nearer to us, not even in our own "local" Orion arm of the Galaxy. This raises the question, then, is the galactic magnetic field near the sun very low or that in the Perseus arm very high?

Verschuur cites James J. Rickard of the University of Maryland, who earlier this year wrote in the *Astrophysical Journal* that one or more supernovae exploding less than 30 million years ago in the Perseus arm might have amplified the existing magnetic field. A search for Zeeman effects in other parts of the Galaxy should make it possible to resolve the two alternate theories.

A PECULIAR VARIABLE In the northern constellation Sagitta (the Arrow), a second-generation supergiant star appears to be throwing off its second planetary nebula in 3,000 years. The star has brightened steadily from about magnitude 13.5 in 1894 to 9.5 at present and shows no sign of stopping.

Not until 1955 did photographs reveal that the star, FG Sagittae, was centered in a faint, nearly circular, nebulous envelope about 18 seconds of arc across. Now, analyses of the star's spectra show hot gas flowing outward from the center at some 40 miles a second—too slow for a nova, but just right to fit present theories of how planetary nebulae are formed.

In 1961 George H. Herbig of Lick Observatory and A. A. Boyarchuk, a Soviet astronomer now at the Crimean Astrophysical Observatory in Nauchni, began a study of this "peculiar" variable. They presented their findings this year in the *Astrophysical Journal.*

At the star's estimated distance of 8,000 light-years, the existing nebula would have reached its present true size of about six-tenths of a light-year across had it begun expanding at 40 miles a second 3,000 years ago. The authors add that if FG Sagittae began throwing off another shell about 1895, the new nebula should now have an apparent diameter of eight-tenths of a second of arc. The brightness of the central star would mask the surrounding disk on photographs, however, so we will have to wait many years before knowing for certain if we have witnessed the birth of a planetary nebula.

MAYA ASTRONOMY In years past, astronomy has been called upon to explain the Star of Bethlehem and the geometry of Stonehenge. Now it has been invoked to explain the importance of certain dates in the Maya calendar.

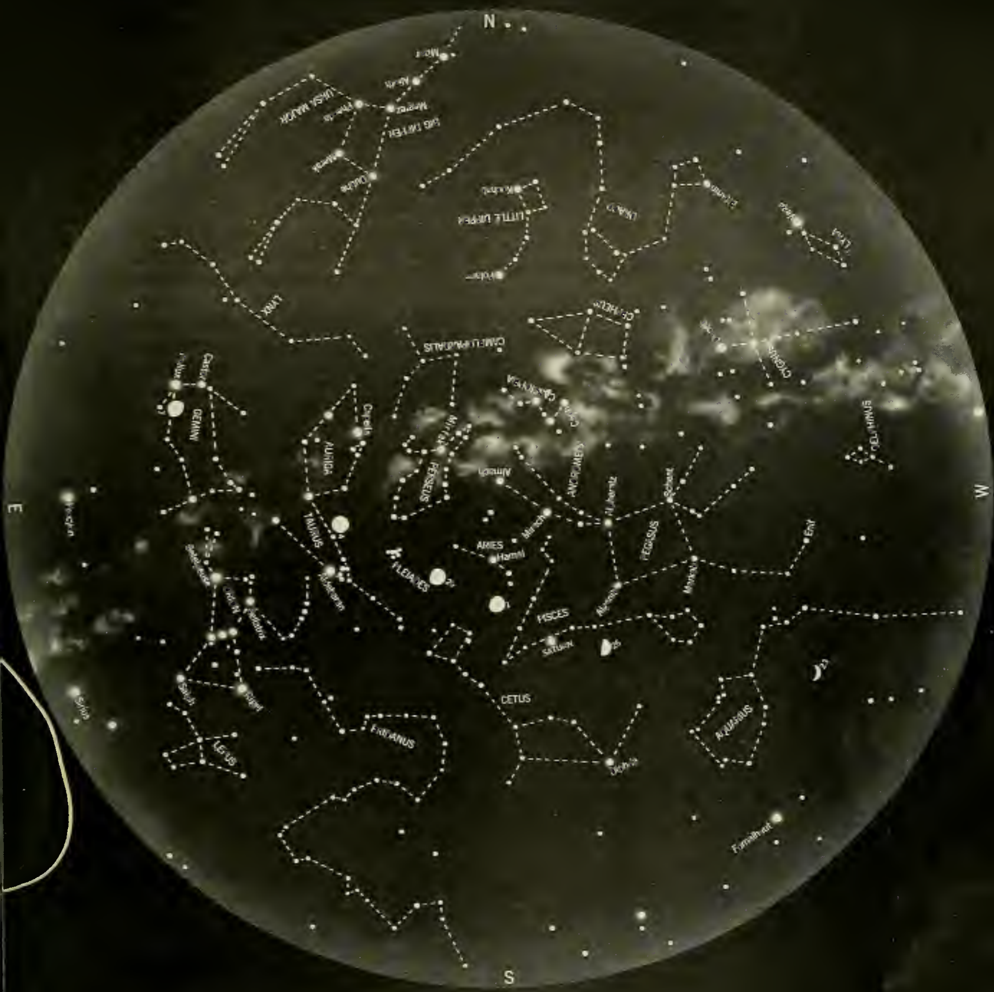
At a meeting of Maya wisemen held at Lake Bacalar, in what is today eastern Mexico, it was decided that February 15, 1544, was identical with 11 Chuen 19 Zac, the date of a mysterious anniversary. But the Maya never said what the date signified. Charles H. Smiley, chairman of the astronomy department at Brown University, offers an answer. After ruling out such obvious events as eclipses, Smiley consulted tables of planetary positions for the last 2,000 years. He found that on February 15, 1544, Saturn and Jupiter approached each other in the sky and, moving in retrograde, remained almost in conjunction for 60 days.

Reporting in the *Journal of the Royal Astronomical Society of Canada*, Smiley also said that in A.D. 93 and 94 Maya astronomers predicted conjunctions of Saturn, Jupiter, and Mars with the sun—events they could not have seen.

FOR THE GROUND OBSERVER Planetary astronomers still get the most information per dollar from ground-based instruments, despite the exciting revelations of space probes. The National Aeronautics and Space Administration (NASA) is the first to admit this, and last summer paid for a study of what new instruments were needed to take advantage of new techniques.

The 17-man panel came up with a list that shows the revolution in methods occurring in the ancient science. The group asked for a new 60-inch optical telescope in the Southern Hemisphere to concentrate on planetary work, but at the top of the list it placed new radio and radar telescopes and a 120-inch telescope designed to work in the infrared region of the spectrum. The panel also urged the development of new detectors for radiation in all regions of the spectrum, from near ultraviolet to microwave. And more work in laboratory spectroscopy was recommended to better interpret new data.

Finally the panel suggested a worldwide photographic patrol of the planets through January 1, 1974; better measurements of the motions of asteroids and comets; and greater efforts to recover meteorites and other extraterrestrial material. JOHN P. WILEY, JR.



CELESTIAL EVENTS

The moon will be in the evening sky in early December, becoming full on December 4 and then moving into the morning sky. Last-quarter moon is on December 12, new moon on the 19th, and first-quarter moon on the 26th.

Venus becomes brighter, appears higher, and sets later in the southwest at dusk. Saturn, also an evening star, is well up in the east at sundown and sets after midnight. Jupiter and Mars, both in Virgo, rise after midnight and are high in the south by dawn.

December 6: Mercury, at superior conjunction, enters the evening sky.

December 13: The Geminid meteor shower, producing up to 50 meteors per hour for the single observer, reaches maximum. The late crescent moon should not seriously affect early morning observations.

December 13-14: Jupiter is to the left of the moon in the morning sky of the 13th; to the right on the 14th.

December 15: The late crescent moon passes near Mars this morning and then occults the bright star Spica, shortly after 3:30 A.M., EST, for observers in the eastern United States and Canada.

December 19: Perigee spring tides occur today, with higher than normal high tides. Perigee (when the moon is nearest earth) comes about six hours before the new moon.

December 21: The sun arrives at the winter solstice at 2:00 P.M., EST; winter begins in the Northern Hemisphere.

December 22: The weak Ursid meteor shower (about 15 meteors per hour) reaches maximum, with no moon to interfere.

December 27: The bright object to the right of the moon this evening is the planet Saturn, in Pisces.

THOMAS D. NICHOLSON

★ Hold the Star Map so the compass direction you face is at the bottom; then match the stars in the lower half of the map with those in the sky near the horizon. The map is for 9:15 P.M. on December 1; 8:20 P.M. on the 15th; and 7:20 P.M. on the 31st; but it may be used for about an hour before and after those times.

THE DISCOVERY OF

America's first inhabitants probably came over a land bridge that once connected Siberia with Alaska, but that is now the waterway called the Bering Strait. How long has it been since that emigration to the Western Hemisphere?

Some archeologists and anthropologists guess that man has now been in the Americas for the past 30,000 or 40,000 years. This would put his arrival at about the time that Cro-Magnon man was displacing the Neanderthals in Europe. But facts are more important than guesses, and one way to get facts is to seek for the oldest fossils and artifacts that can be reliably dated.

Probably the strongest candidate that diggers have found so far has come, this year, from the southeastern corner of the state of Washington. There, in a small river canyon, digging crews from Washington State University have found skulls and other valuable testimonials to the existence of the American nomad, Marmes Man. The expedition leaders, geologist Roald Fryxell and archeologist Richard Daugherty, expect completion of carbon-dating examinations to confirm that this prehistoric hunter was on the American scene between 11,000 and 13,000 years ago. This would make his skeletal remains the earliest reliably dated ones in North America, and perhaps contemporaneous with the last stages of the Ice Age.

The finds, along the Palouse River near its juncture with the Snake, began last April and have been undergoing dating tests at WSU's Laboratory of Anthropology, Pullman, Washington. They came as unexpected reinforcement of previous evidence (NATURAL HISTORY, February, 1967: "Cave Life on the Palouse") found in a wide, shallow cave that diggers named Marmes rock shelter after Roland Marmes,

MARMES MAN

By RUTH KIRK

owner of the property. The earlier work, spanning several years, was concentrated at the rock shelter and showed a record of human occupation going back to nearly 10,000 years ago. The newest evidence was dug up after a bulldozer stripped the surface of the river flood plain below the rock shelter.

Marmes Man is actually more than one individual. There are three separate, broken skull caps, including that of a young child, together with other skeletal material. In addition, the excavators turned up evidence of a campsite, a probable cremation hearth, and artifacts, including fragments from a bone spearpoint, and a delicate one-inch-long bone needle. The bones of an elk, on which Marmes Man presumably fed, show that this animal may have been from 10 to 20 per cent taller at the shoulder than the modern elk.

The finds lay sandwiched in time beneath, and therefore older than, a thick deposit of rockfall and some mussel shells; and above, therefore younger than ancient lake deposits tentatively estimated to be 13,000 years old.

Such dates do not, of course, indicate when the first men—possibly hunters—crossed from Asia. But that such descendants as Marmes Man went on to spread through the Americas is indicated by the finding of skulls, perhaps 10,000 years old, at Tepexpan, Mexico, and Midland, Texas; skulls about a thousand years older have been found at the southernmost tip of South America —in Chile at the Strait of Magellan.

The importance of the Marmes finds lies in the abundance of well-documented evidence as well as its actual age. All told, the Marmes site has provided skeletal evidence of 23 human burials, ranging from 200 years to more than 11,000 years old —the longest span of human pres-

ence yet found in the New World.

Also important is the association of these human bones with bony material of other creatures. The fineness of the bone needle, for instance, indicates it was used for fine stitching and close seams—possibly for sewing waterproof clothing. Other artifacts made of animal bone include a variety of scrapers. In addition to the bones of an elk, the excavators recovered bones from such relatively large animals as deer, antelope, and coyote or wolf. Butchering marks show on many of these, and some had been cracked open, presumably for the ancient humans to get at the marrow.

Painstaking efforts were taken by the diggers to insure that nothing of value would be overlooked. Each wheelbarrow load of dirt from the excavation was first shaken through $\frac{1}{4}$-inch-mesh nylon screen, then washed to recover such minute material as rodent teeth and bones, tiny snail shells, and seeds that may indicate what plants Marmes Man used. In this fashion the needle was discovered—in three separate pieces that fit together perfectly.

The probable date for the cremation hearth has been set at from 9,000 to 10,000 years old—as old as any such site known in the Americas.

Of their contribution, codirectors Fryxell and Daugherty say: "What we have is not only ancient human bones, but a wealth of information of what the men were like physically, what kinds of tools they made, what animals they hunted, and what the environment was like . . . when Marmes Man called this area home."

At left: assembled from three pieces, the bone needle (shown below a modern steel one) demonstrates Marmes Man's delicate craftsmanship. Below: arrow points to the rock shelter—the cave is in a wall of flood-gouged Palouse Canyon, 1½ miles upriver from where the Palouse runs into the larger Snake River (map shows their confluence). Bottom: a student worker screens diggings beside Marmes rock shelter while others work below. Far left: these fragments of Marmes I skull are from an adult about 20 years old.

Ecology *continued from page 16*

we'll solve the problems, but it does mean we stand a fighting chance. Without it we don't.

Question: Dr. Gates, in establishing or being able to establish the latitude of environment in which given animals or species can exist, has there been any research to establish the ability of animals to change and adapt to a new or varied environment?

Dr. Gates: This is an interesting question. It reminds me to say to you that one of the outstanding characteristics of man is his impulsive nature. He delivers enormous impulses on the environment, on the surface of the earth, and so the changes that take place under the hand of man are far quicker and far shorter than the whole evolutionary system has ever had to deal with or respond to. This is the trouble. Man is changing the climate, we know this. The change is taking place within decades, very quickly. But the ability of the oceans to take up CO_2, or the ability of other parts of the system to adjust, is on the order of hundreds of years or thousands of years. And so everything that man does is impulsive. Now, your question of the adjustment of animals. Animals have evolved an incredible combination of features in order to adapt to environments. Animals, like men, keep their body temperatures within very narrow bounds. We have adapted by putting on clothing, by building houses. In this way, we've used our cleverness. And so have many other so-called homeotherms that have rigidly controlled temperatures. They have burrows in the ground, they have fur as protective clothing. The cold-blooded animals, like lizards and other reptiles, have to utilize other ways of trying to adjust. A lizard, for instance, can usually withstand body temperatures to about 104° F. And so, they have a different type of adjustment. Well, from a behavior standpoint, there are many, many examples of the way animals have learned to respond to a system. And, of course, we do ourselves.

Dr. Holling: The question really concerns itself with the stability of natural systems in the degree to which they can absorb disturbances, and this is really the central question that ecologists have been facing.

do know that, despite the argu-
nts for the delicate balance of ure, natural systems are pro-ndly resistant to change. They e exposed to catastrophes, natu-catastrophes, long before man ap-red on the scene; and in order survive these catastrophes, they eloped mechanisms to stabilize ir population or their community. , we do know that this resistance 't infinite; that we can turn a est into a desert. So the question umber of ecologists are asking v is what are the properties or mechanisms in natural assem-ges of organisms that account the degree of stability that they w and how does this vary. The ite taken, and this is the route a oup of us are following at the Uni-sity of British Columbia, is to try develop mathematical models that fed by an experimental program-ng of the various processes that ganisms undergo—things like pre-tion, competition, disease develop-nt, dispersal. And we've devel-ed these models so that we honor ee requirements. We require that y be general, that they be realistic, d that they be precise. We've been ccessful to the point that in preda-n, for example, we've been able develop a generalized model of edator/prey interaction that, with aid of the computer, allows us simulate a variety of conditions. e computer is essentially a cage ose inhabitants we can switch m praying mantids to tigers by rely changing numbers. And in ing this, in generating our simu-ions, we discover that some in-action between predators and ey begins to oscillate and gradu-y go up to infinity or go down to ro. But, we discover other simu-ions, we mimic other situations, which these oscillations are sta-lized to produce a system that is ry resistant to a disturbance or ovocation. And we began to be le to identify the exact causes of e instability and the mechanisms at have evolved to tune the systems the existing conditions. Much of e instability came because the sys-ms react to the past. They have a nd of memory.

The animals that are present at is moment of time are such because a certain evolutionary and genet-history. The predator that is at-cking at this moment of time owes

the vigor of its attack to the number of meals it's had in the last few days. The size of the predator attacking at this moment depends upon the nutritional history it was exposed to while growing; it depends upon the nutritional history of the parents. So, we have those systems and the organisms within them continually responding to past events. The point is the events may not be appropriate for the conditions of the present. And so, we are getting a sense for the mechanisms that account for instability and the counteracting mechanisms that have evolved to produce stability. It's this kind of knowledge that is necessary when someone suggests weather control through cloud seeding. What impact is this going to have on the natural assemblage of animals that has evolved in the context of quite a different time? We can begin to answer this kind of question.

Question: I have a question for Mr. Harrison. Early in your talk you emphasized that the concern of these grants and of the programs that you support will be man in relation to his environment, concern for intelligent and conservative exploitation, and I think it makes a great deal of sense and is certainly what the public wants to hear the Ford Foundation is supporting. Well, in light of some of your subsequent remarks on the kinds of studies that Dr. Gates emphasized, I wonder whether there's a broader philosophy being supported here, something which is really quite different. And that is that man is only part of the whole ecological system. And that, in fact, you're just as concerned with other creatures and their preservation. For example, the whooping crane for the sake of whooping cranes. How, in fact, is the Foundation concerned.

Mr. Harrison: Well, I'd have to give two answers to that. One is kind of an ethical answer. I personally feel strongly that man shouldn't be so arrogant that he feels that all other creatures must live only by his sufferance, but this is not the larger answer. The more significant answer is that we are convinced that man is in fact dependent on these existences, and that if he destroys them, he is going to destroy himself. So that you can look at it from either point of view. We can only guess that there's some kind of ethical system that en-

les other creatures, as well as our-.ves, to an existence, but we do ow, and this is abundantly illus-ıted, that our own dependence is ry real. Now, you can find some r-out examples, and maybe the ıooping crane is one. I don't know any immediate economic advan-ges to man of preserving the ıooping crane, but I do know that ıe of the reasons the whooping ane is disappearing is because the vironment, by man's action, has en homogenized in a way and at this is not only destructive of e whooping crane but probably structive of a variety of the ıman life. This is a direct human ncern.

Question: Dr. Gates, you men-ıned being able to predict a few the climatic niches for some ani-als. How about a couple of "for stances"?

Dr. Gates: O.K. One animal, the g, which we depend upon for food. has no fur, no feathers, but it does ıve lots of fat. Fat is not as good insulation as fur or feathers. We ke the metabolic rate of the pig, ıich is a built-in physiological aracteristic. It has to have a rela-ely fixed body temperature; it's out 100° F., 98°, something like at. And we end up showing in rms of absolute numbers, so that can express every relationship ecisely, that the pig cannot with-ınd the American Midwest in the ldest winter weather. Now, some-ıe says to me, "But there are pigs the American Midwest in the win-r." Yes, but they have shelter. They ıve small houses or they cluster, d when they cluster, they cluster the corner, the protective corner the field, all hunched up together modify the climate so they will rvive. We've mentioned this to pig rmers and others, and they say, ndeed, this is true; the pig will not thstand the coldest weather in the merican Midwest." Now you know at and you say, "So what? Why all this work to find out?"

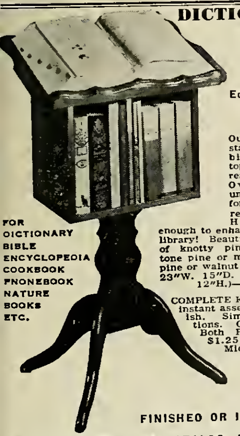
But now, we can predict precisely e limits to such an animal. Still, e big problem is the scarcity of ta, the scarcity of basic informa-ın concerning the properties of the imal. It's a shocking thing, but don't even know the metabolic tes on vast numbers of animal spe-es. We think that we're living in a etty advanced state of society and

science, but it is my personal fee[l]ing that the present state of the a[rt] in ecology is exceedingly primitiv[e]. This science has lagged very ser[i]ously, and we've had this enormou[s] polarization, to which I referred. W[e] go to incredible expense to map th[e] ionosphere and the electron densit[y] overhead, but we do not have an[y] map, in detail, of the microclimat[e] of the surface of the earth on whic[h] we depend. Now, the whole scienc[e] of ecology is way, way behind an[d] it really must get moving. We de[-]pend on it desperately.

Question: I was wondering i[f] Dr. Holling could elaborate on som[e] of the factors which create stabilit[y] or instability as implied by you[r] computer models. Are there an[y] surprises there or again is that over[-]applying what we already know?

Dr. Holling: I can give you som[e] specific examples. We find that whe[n] confronted with exploring the prop[-]erties of the mathematical model[,] one of the initial steps is to drop a lot of the parameters to zero or pus[h] them up to infinity to make a highl[y] simplified thing to explore limitin[g] conditions. And under those condi[-]tions, we get enormous instability[.] And then we reintroduce values be[-]tween zero and infinity to thes[e] parameters, and we find a variety o[f] tactics by which stability is sud[-]denly achieved. Let's define on[e] kind of instability. As populations o[f] the prey are going down, becaus[e] of the impact of predation, at an[y] moment the number of predator[s] gobbling these things up are th[e] product of previous generation[s] when there were more prey. In ef[-]fect, there are too many predator[s] and they're pushing the prey popu[-]lation down too far. To tune thi[s] system, not to the past, but to th[e] present condition, you can exploit a number of tactics.

Tactic number one is to have a predator that uses its energy ineffi[-]ciently when prey are abundant bu[t] very efficiently when prey are scarce. Under these terms, suddenly th[e] system becomes chained by this par[-]ticular tactic. and there are a variety of tactics of this kind. By taking thi[s] route we then begin to ask, in ap[-]plied terms, to what use can we pu[t] this kind of information on the tac[-]tics of organisms. If we're con[-]fronted with pests of a crop, we ca[n] adopt one of two strategies. We ca[n] say, "Let's do something to reintro-



duce stability." That's adopting some of the same strategy of nature, as Mr. Harrison pointed out. Or we can precisely define an alternate strategy, which is to produce massive instability in this little local part of the problem and, therefore, adopt a strategy and produce an animal that nature could never produce, because it would be contrary to her strategy. We could, using this tactic, develop a genetically rearranged program that would produce a predator that operated in just the opposite way, yet was less efficient in its energy in utilization when prey was scarce. And in so doing, we would introduce an element of instability that could lead to elimination of the local population. This kind of route, therefore, is now opening up a new number of tactics that were unsuspected and providing alternatives to the quick technological fix.

Let me take one of the examples that gets off stability, but demonstrates some other points. When developing this model of predation, at one point we had to concern ourselves with the way prey reacted to predators. And it turned out that there was a particular tactic by which prey in their different circumstances adopted various escape routines, various trajectories, when a predator was approaching. We insisted, as I mentioned before, that we have a generality, and so we developed a generalized model, and it became evident that quite unsuspectingly we had a model that showed the way animals react visually to objects in their environment. The object might be something to eat, it might be something to run away from or to hide in, but the model could generate all this.

The experimental situation involved some work done in Hawaii with a schooling fish that is like an anchovy, and we were looking at its reaction to barracuda. Now, it has subsequently turned out that because of this insistence on generality, our model has relevance for determining traffic flow on highways, because there you have a situation where the animal, the human being, in one car is trying to avoid the car ahead of him, the car on the side of the road, and so on. As I said, it turned out that this model can be used to predict and to optimize traffic-flow situations. It has also generated information that seems to be

useful in analyzing the bird collision hazard for aircraft. As aircraft have speeded up, there has been an increase in accidents caused by birds being ingested by the engines. And the third and somewhat more obvious fallout of this insistence on generality is the design of a fishnet that is vastly more efficient in harvesting. Now, that's another quick technological fix. It's the kind of fix that the Food and Agriculture Organization came up with when they went to Peru and, through the development of harvesting and food-processing techniques, developed an industry to exploit the vast numbers of anchovetas that are found off the Peruvian coast. They were so successful that in a period of fifteen years the anchoveta industry has grown to produce one-fifth of the world's fish protein. It's the single most important industry in Peru. Overcapitalization in gear and the use of more efficient fishnets has led to overexploitation of the resource. The resource is now declining, and the economy in Peru is threatened. This is another one of the chains similar to the kind Mr. Harrison described in Borneo, but again, we can enter at this point and develop a model that can simulate the anchovy situation. And such a model is being developed in one of the Ford Foundation-supported programs at the University of Washington. This model incorporates the biology of the situation. As for the economics of the industry, man can play management games with the model to find out ways to manage this situation so that economic instabilities of the kind I just described don't occur.

Question: There's been a great concern about the total pollution here in New York City—air, water, noise, and everything else. It seems that no one has really studied the total problem. Is that of interest to the Foundation?

Mr. Harrison: It is, and we have had some nibbles about this kind of general approach to the pollution problem. As a single problem—distinct from trying to solve the individual problems of water, air pollution, and solid waste disposal—it's a terribly difficult area to get hold of. So far, we have not had a proposal along this line that made sense.

Of course, a lot of people are studying the specifics on water pol-

ıtion and air pollution and so on -the technology and the methods of ontrol. This is being fairly gener-usly supported by the federal gov-rnment and that is the reason we ave not, ourselves, been deeply oncerned with it. One of the things ıat we feel it is important for the oundation not to do is to add money nd support to fields that are already ɜceiving substantial largess, unless ıere are some aspects of research ıat are not normally being covered r unless we can explore new meth-ds of handling the problem. We on't confuse ourselves with the ɜderal government and we don't ave this kind of resources.

I could mention the work of Re-ɔurces for the Future, which has een wholly Ford-supported, in the evelopment of the kinds of models ıat Dr. Holling is talking about, in pplication to pollution problems, articularly. And they are working, think, sensibly, with stream basin roblems, which are relatively sim-le and concrete. Then they are also ying to develop a model that would pply to air pollution problems as ell. They hope, if these models ork out, to be able to link them ɔgether to obtain a model of the ɔtal pollution problem in a defined eographical area. This varies some-hat from what Dr. Gates said arlier about the solution of many f our environmental problems in-olving all the disciplines. Certainly, we talk about the ecology of New ork City, there's scarcely a disci-line that wouldn't be meaningfully ıvolved. But probably what is eeded first is some mechanism for ıese disciplines to touch hands in-ɛllectually. Until the disciplines arn to talk to one another, through ıe dialogue of a problem of com-ıon interest, it's not very likely that nything useful will come of it.)urs is an effort to build bridges etween disciplines, so that you will ıen have teams that can look at ırge-scale problems. But, there is a aining problem first.

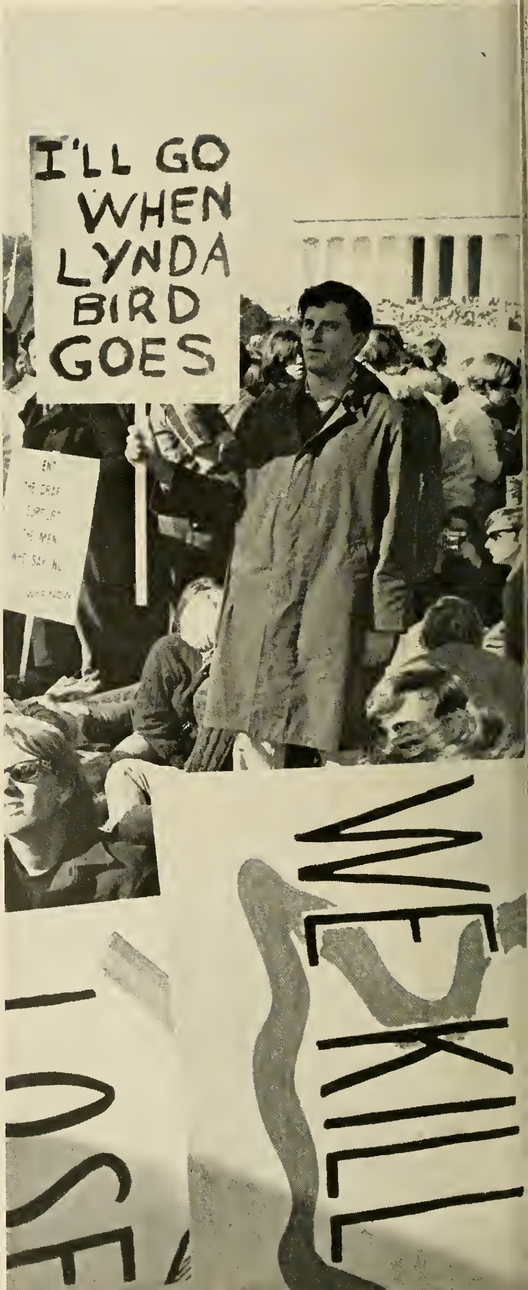
Dr. Gates: The people just don't xist to handle these critical prob-ɛms that we have now. And, it's too ad we have to go back and start roducing the people when we al-eady have the problems they should e solving, but the fact is that we o have to. And so we face these rises now with inadequate human esources to deal with them.

Books in Review

Toward a science of humanity

by Helmut K. Buechner

Today's youth, caught up in an increasingly technicized society, rebel against established social and political philosophies.



ɔo HUMAN AN ANIMAL, by René Dubos. *Charles Scribner's Sons, $6.95; 267 pp.*

For several years René Dubos and a few others have been advocating a new science, one in which the natural sciences, the behavioral or social sciences, and the humanities are integrated on a common theme of man and his total environment. While the need is clearly evident in our current environmental crisis—the outcome of overpopulation and technology—no one has yet succeeded in formulating new concepts, principles, and methodologies for a science of humanity. The present book was written in the faith that it is possible to deal scientifically with the living experience of man. It does not provide the foundation for the new science. It does, however, provide the most coherent and lucid insight available as to the directions of inquiry that are imperative for the full unfolding of the rich potentialities of the human species, and it provides the philosophical background for the new science.

A science of humanity must be based soundly on the biological limitations of man as determined by his evolutionary past, on the current process of adaptation to new environmental factors, on the governing influences of environmental factors in the formative stages of life (natal and postnatal up to six years of age), on the limitations of spaceship Earth, on the reversibility of early influences, on the highly personal interplay between a particular human organism and its environment, on the interplay of society as a whole and its environment, on the phenomenon of free will through which human beings transcend the constraints of biological determinism, on the ingredients of environmental diversity that will enable the greatest number of human genotypes to develop their peculiar abilities, on an understanding of the regulatory processes of natural systems, on the impact of man's modifications on the structure and functioning of ecological systems, on the psychological effects of overcrowding, on the delayed physiological and psychological effects of environmental pollutants, and on many other ideas and areas of knowledge with which this book is concerned.

The new science, René Dubos points out, cannot be developed through the reduction approach of traditional science, in which the components of a system are broken down into ever smaller pieces with the conviction that ultimate understanding lies in knowing all there is to know about the parts. A humanistic science will require new concepts different from, and complementary to, present biological theories. Human beings, society, and man-and-his-total-environment are functioning wholes in nature with unique attributes that cannot be understood by analyses of the parts alone. New philosophical approaches are needed, emphasizing the holistic nature of man and of the natural systems of which he is an integral part. These are new frontiers that have not yet lent themselves to rapid professional advancement. Dubos' new book helps make them acceptable, and it will help to spur young rebels and liberal universities toward action with more relevance in the contemporary world than the traditional specialties.

The worldwide rebellion of the young in the economically affluent countries seems to provide a cybernetic signal of the psychological consequences of overpopulation and the lowering of those qualities of life most closely identified with humanness. Overcrowding is likely to cause psychological damage. "To some overcrowded populations violence or even the bomb may one day no longer seem a threat but rather become a release." At least it is already evident that present human values may become meaningless in a regimented life required for survival in overcrowded and highly organized urban environments. It is in today's rebels, who revolt against current social and political philosophies, that Dubos sees hope for the future. They are, however, rebels without a cause. If they really want a cause, it can be found in *So Human an Animal*, for much of the book is concerned with a new optimism and the search for significance in life. They will see more clearly what is happening to them in our increasingly technicized society. Dubos' book is a major contribution to an understanding of what is going on in the world today and what it means to the individual, to society, and to the future of mankind. It gives meaning to the need for a new science of humanity and generates fresh ideas as to how we can proceed.

In this book, as in much of his earlier writing, Dubos is deeply concerned with the myth that "because man has an infinite capacity to adapt to changing environments, he can endlessly and safely transform his life and indeed himself by technology," and he again stresses the biological and psychological limits to man's adaptability. It is significant that Dubos is as well informed on the human attributes of man as he is on man's biological attributes. The combination, in one person, of a thorough biological knowledge of man and an unusual depth of understanding of humanness is reflected throughout *So Human an Animal*. This is what makes the book unique, and what makes it particularly important now.

Dubos' discussions of the contemporary problems of life against a background of biological and psychological principles will provide legislators, teachers, non-biological scientists, and the educated public with accurate information, sound thinking, and clear ideas as a basis for intelligent social action. For this reason his book is likely to have an impact on society similar to, or greater than, Rachel Carson's *Silent Spring* or John Kenneth Galbraith's *The New Industrial State*. It is a timely contribution, beautifully written, and it will be read eagerly by all who are deeply disturbed and concerned with the present ecological crisis.

Dr. Buechner is Head of the Office of Ecology at the Smithsonian Institution and the author of over seventy technical and professional articles.

IN THE WAKE OF THE SEA-SERPENTS, by Bernard Heuvelmans. *Hill and Wang, Inc., $10.00; 645 pp., illus.*

Because the earliest well-known reports about sea serpents came from Scandinavia, there is still a tendency to think of icy waters, misty fjords, and surf-splashed, rocky coasts when the name is mentioned. This tendency is as wrong as the name, for the animal dubbed sea serpent is not a

serpent (and very likely not even a reptile) and is usually seen in warm waters and in good weather.

Up to about the middle of the nineteenth century, reports on sea monsters were accepted by most readers on the still-valid assumption that the seas are large and can easily hide undiscovered animals. During the second half of the nineteenth century, the situation became complicated, at least for Englishmen. Sightings of sea serpents were reported by captains of the Royal Navy and should be believed for that reason alone. But at the same time England's greatest living zoologist, Sir Richard Owen, categorically denied the existence of such an animal and dismissed the sea captains' reports on the grounds they they were not "trained observers"—not professional zoologists.

Late in that century a Dutch zoologist, Dr. Antoon Cornelis Oudemans, decided to follow a precedent set in another branch of science. The question of whether "stones" had fallen from the sky had been a controversial item, until Ernst Florens Friedrich Chladni systematically collected all such reports and made it clear (in his book *On Fiery Meteors*, 1819) that stones did fall from the sky. Oudemans began to collect sea serpent reports. After rejecting obvious hoaxes and mistakes, he had 162 sightings that he accepted. (It should be borne in mind that there are less than a hundred sightings of the whale shark, which is known to exist.) From these sightings he constructed an animal that he thought to be a long-necked pinniped; its shape is best described by saying that it looked like a brontosaur with flippers instead of legs. In 1892, Oudeman's 592-page work, entitled *The Great Sea-Serpent*, was published but it was not accepted as Chladni's book had been.

In spite of the scorn (mixed with some praise) Oudemans continued to collect reports until his death in 1943 at the age of 85. Heuvelmans, himself an assiduous collector of such sightings, was permitted to use Oudemans' archives. One might say, therefore, that his book is Oudemans brought up to date. Heuvelmans lists 49 definite hoaxes, 52 probable mistakes, and 358 sightings that he accepts. Unlike Oudemans, he comes to the conclusion that several unknown animals have been seen and called sea serpents, among them a long-necked type similar to what Oudemans deduced but with a very short tail; a "merhorse" with a shorter neck and a mane; a many humped animal; a many finned animal, the "fins" are just appendages; a superotter; a supereel; a marine saurian of the general shape of a crocodile; and two more uncertain types.

It is fruitless, at this time, to engage in a long discussion of whether he is right or wrong. the only attitude one can adopt is that of wait and see. The marine saurian has been seen only four times, but the reports are very definite. The supereel has been seen twelve times. but again the reports are very definite, and a six-foot eel larva (*Leptocephalus*) is in a museum in Denmark. The other types have been seen more than twenty times, the long-necked type holding the record with 48 sightings. Zoologically speaking, the supereel is, of course, a fish; the ma-

Biblical Leviathan, as drawn by Gustave Doré, is an illustration from "In the Wake of the Sea-Serpents."

rine saurian is a reptile; and all the others are, most likely, mammals.

Of course the existence of this book will cause a renewal of the discussions. Chladni was aided by a few spectacular falls of meteorites that occurred soon after the publication of his book. Maybe fate will be kind enough to aid Dr. Heuvelmans in a similar manner.

WILLY LEY
Scientist and Author

THE RISE OF ANTHROPOLOGICAL THEORY: A HISTORY OF THEORIES OF CULTURE, by Marvin Harris. *Thomas Y. Crowell Co., $16.50; 806 pp.*

Anthropology is relatively small and recent as an academic discipline. As a subject, on the other hand, it is enormous—man and his works, past and present, anywhere in the world—and interest in anthropology is as old as man himself. Dr. Harris has therefore made a wise decision in not limiting himself to the recent academic phase.

The main currents of the British and French Enlightenment included the beginnings of a scientific anthropology, which Harris reasonably places in 1690 with Locke's *An Essay Concerning Human Understanding*. Harris' first 250 pages treat anthropological thought from then until the American academic phase began under Boas around the turn of the twentieth century. The author performs an important service here in countering academic anthropology's tendency to ignore its roots in the Enlightenment. His discussion of the eighteenth-century writers is particularly well taken, and he reports their work with apparent care and sympathetic understanding.

But as he moves into the modern arena to combat the academics, the book turns into a free-swinging critique rather than a history of ideas. The best of these chapters is directed at the idealist and scholastic triviality of the so-called ethnoscientists (the "new ethnography"). The criticism is well done, as is the treatment of the related French structuralists. But everybody is told off eventually—sometimes mistakenly and misdirectedly. His treatment of cultural evolutionism (both classic and "neo-") was, much to my surprise, unsympathetic and inept. With respect to the evolutionist authors I am most familiar with—L. H. Morgan, L. A. White, M. D. Sahlins—I found Harris' scholarship shockingly bad. Since it seems unlikely that he would concentrate his mistakes on these few, it must be that other authors were unread or misread, as well.

The title and plan of the book suggest that the evolution of anthropology had its general theoretical beginnings in the Enlightenment, with some regression in the nineteenth century, fol-

d by an evolutionism that had y flaws until Marxian materialism ected them. The academic anthropogy of the present century had its heoretical, particularistic phase. wed by many floundering attempts evive theory in our own day. The s for the criticism of these attempts lly becomes apparent: they are ingly bad depending on how far depart from Harris' version of t he calls cultural materialism.

his materialism holds that causal nacy in cultural change is to be nd in the technoenvironmental and noeconomic sectors of culture, with ial and ideological aspects to be reded as dependent variables. But this iot put as theory: it is simply stern nonition about what should and uld not be done in research. Few hropologists will be convinced that portant evolutionary changes must ginate in the above order. But above should not causality be sought by scientist wherever it occurs? Adtedly, it is not easy to find: following logma is easier.

Thus the book simply peters out. ice it begins so interestingly with the eat philosophers and ends with only tiques of contemporary triviality, the ok is mistitled; what it describes is e *demise* of anthropological theory.

ELMAN R. SERVICE
University of California, Santa Barbara

OUND BUILDERS OF ANCIENT AMERA, by Robert Silverberg. *New York raphic Society, $8.95; 369 pp., illus.*

This book is a must for anyone whose imagination has been stirred by the icient mounds of the eastern United ates. Today many of these mounds are rotected in state and national parks, here they appear as grassy knolls borered by paths, and the inevitable brick arbecue hearths and picnic tables. thers may be seen in forested areas, here their antiquity is brought home o the visitor by the sight of substantial rees growing on and around them. As n the past, they evoke a sense of mysery and curiosity about their origin.

The book traces the history of ideas nd speculations surrounding the nounds, from the early descriptions by De Soto and other sixteenth-century explorers to the present efforts of scienific archeology. Mr. Silverberg subitles his book *The Archaeology of a Myth*, and the history of ideas he presents is essentially cyclical. The earliest Europeans and Americans to describe the mounds more or less accepted the idea that these monuments were left by the Indians. In some instances, it was clear that the Indians still constructed earth mounds atop which they placed both temples and the chief's house. But

by the end of the eighteenth century a new interpretation was beginning to take hold—that the mounds were constructed by some highly civilized society and/or race that bore no relation to the historic Indians of the region.

A variety of theories arose about who these mysterious mound builders might have been: Toltecs, Phoenicians, Hindus, Malays, Vikings, Tartars, the ten lost tribes of Israel, all were invoked by different authorities and popular writers of the late eighteenth and early to mid-nineteenth centuries.

Some scholars called for more evidence and attacked the idea of non-Indian mound builders, but their opinions remained isolated and largely ignored throughout this period. Ideas that today comprise the lunatic fringe of American archeology were majority opinion then. Why? Mr. Silverberg suggests two major reasons: 1. The need for a proud young nation to find vanished civilizations in its past to rival those of Stonehenge, the pyramids of Giza, and the monumental ruins of other countries, and 2. At the same time, the dispossession and downgrading of the American Indian as part of this country's westward expansion. These are both reasonable suggestions, although, from a historian's point of view, the author's demonstration of these motives is incomplete. This is a minor fault, however, since excessive pursuit into the origins of the mound builder myth might have made the book pedantic. Silverberg shows the historical importance of the myth, leaving it to the historians to probe its causes more deeply.

The story comes full circle when the author shows how empirical archeology gradually discredited popular beliefs. In particular, he singles out the Herculean efforts of John Wesley Powell and Cyrus Thomas of the Bureau of American Ethnology to restore to the Indian his former recognition as the builder of the mounds. This section might have been clearer if some mention had been made of the ideas about cultural evolution that were current in the late 1800's, particularly those of the influential anthropologist Lewis H. Morgan (who is never mentioned in the book).

The author's narrative concludes with a quite creditable summary of recent and current archeological views on the ancient Indians who built the mounds (including a treatment of both the Burial Mound people, the Adena and Hopewell, and the later Temple Mound people, the Mississippians). Mr. Silverberg runs into trouble, however, on side issues. His use of the term "Folsom" is overly broad (". . . Folsom points were found all over the country, from Alaska to Georgia, . . .") combined with a failure to recognize the earlier and more widespread Clovis-point tradition. Also, he states that mastodons were killed and butchered by ancient Americans, a point that has never had absolute archeological proof.

These, however, are minor criticisms of what is basically a fine book. It fills a definite need in furnishing a well-written and accurate account of the facts and fantasies surrounding the ancient mound builders. The book will appeal particularly to laymen and archeologists who have visited the mounds and know something of their grandeur. The numerous line drawings are attractive and pertinent to the text, but some of the photographs fail to do justice to their subject. However, the volume is an elegant production and has a useful index and maps.

RICHARD A. GOULD
The American Museum

Briefly Noted:

THE SCURRYING BUSH, by R. C. H. Sweeney. *Pantheon Books, $4.95; 208 pp., illus.*

Showing a very early preference for animals over people, Mr. Sweeney first arrived in Africa as an entomologist for an English chemical company. His interest soon spread to mammals, birds, and reptiles, and his book is a humorous accounting of his passion to collect, or at least get a close-up view of, everything that walks, crawls, or flies in East Africa.

THE AMERICAN ENVIRONMENT, edited by Roderick Nash. *Addison-Wesley Publishing Co., $2.95; 236 pp.*

A collection of reading on the history of conservation: a broad view that includes selections reflecting philosophical and esthetic considerations of the landscape as well as a record of resource management. The most familiar names are represented—John Muir, Aldo Leopold, and Theodore Roosevelt—along with those less readily identified with "the cause"—Wallace Stegner, Rachel Carson, and Lyndon B. Johnson.

BORN IN THE ZOO, by Heini Hediger and Jürg Klages. *The Viking Press, $8.95; 115 plates.*

This is a book about baby animals for grown-up people. Although preceded by a text on the advantages of zoo life and supplemented by the author's notes on the natural history of the animals, it is the superb photographs themselves that are the book's outstanding attraction. Never slipping into the category of being "cute," these are artful studies of a wide assortment of young animals that inhabit a variety of European zoos. C. B.

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MAIL ENTRIES TO: PHOTOGRAPHIC CONTEST, NATURAL HISTORY, 7 WEST 77th ST., NEW YORK, N.Y. 10024.

DEADLINE FOR ENTRIES: March 15, 1969

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health treatises, and works on herb therapeutics, suggests that many vegetarians are apprehensive about the state of their insides, rather than the crisis of conscience that may erupt when a merciful man dines upon the objects of his compassion.

The religious element in Western vegetarianism rests upon Old Testament authority and comprises selected passages, literally interpreted after the manner of storefront Christianity. Man, looked at from this vantage point, is not at all at the top of his development but rather has suffered, after the Garden of Eden episode, a physical as well as moral Fall. One also finds in the Scriptures equal warrant for eating animal food, as in Genesis 9:3. And man's absolute dominion is made explicit in Psalms 8:6–8. But the vegetarian, like all particularistic interpreters of sacred documents, displays a marvelous ingenuity in explaining away whatever commands in the sourcebook fail to fit the thesis. Vegetarians are reticent on the subject of Jesus Christ, who was presumably not of their persuasion, since he performed the miracle of the seven loaves and little fishes, which fed four thousand men, not counting women and children, with seven baskets of fish left over.

The first, organized vegetarian religious group to arrive in the United States left Manchester, England, in 1817. Searching for a Heavenly City, they found Philadelphia. There they established a "Bible Christian" church which practiced vegetarianism in the spirit of the Psalmist—"He causeth the grass to grow for the cattle, and herb for the service of man." At the church the American Vegetarian Society met to denounce the pork packers, dine on vegetarian "mince" pie, and commemorate the birthday of Benjamin Franklin, distinguished Philadelphian and part-time vegetarian. Here too, the congregation raised their voices to sing with the great vegetarian poet Oliver Goldsmith:

> No flocks that range the
> valley free
> To slaughter we condemn;
> Taught by the Power that
> pities us
> We learn to pity them.

The Bible Christian church lasted for nearly a century, initiated the American vegetarian cult, and shaped its thesis. The line of descent from this little band of English fundamentalists to the religious-health-medical tenets of today's powerful Seventh-Day Adventist denomination can be clearly traced.

Although vegetarianism has flourished in the social environment of the last century and this one, all of its ideas and assumptions are thousands of years old and find expression in various Eastern religions: in Brahmanism, Buddhism, and Zoroastrianism. In the West, from at least the sixth century B.C., the practice was incorporated into the thought of the Orphic societies where it fell into harmony with the doctrine of the transmigration of souls. This idea, of the passage of the human soul into another body, perhaps that of an animal, or of the animal soul into a human being, has persisted into the modern era as a half-believed myth, comforting to men of sensitive feeling who see animals suffering, and who are drawn to the hope that the injustices of the present world will be compensated for in another life. Less seriously, the eighteenth-century English poet, John Gay, enjoyed playing with the fanciful notion that the coachmen of London would some day be transformed into the hackney horses they beat so unmercifully, or that draymen would find themselves with bits between their teeth.

In classical literature, Pythagoras advocated asceticism in eating and Porphyry in his *De Abstinentia,* where he viewed men as more than beasts but less than gods, also shrank with abhorrence from the practice of engulfing the entrails of our animal brothers into our own. Vegetarianism claims Socrates and Plato, Plutarch, Leonardo da Vinci, and St. Francis; and coming down the centuries, Rousseau, John Wesley, founder of Methodism, and the poets Cowper, Thomson, Burns, and Wordsworth. Shelley praised vegetarianism for its humane ideals and wrote in *Queen Mab:*

> No longer now
> He slays the lamb, who looks
> him in the face,
> And horribly devours its
> mangled flesh
> Which, still avenging Nature's
> broken law
> Kindled all putrid humours
> in his frame.

The poets celebrated the unity and sacredness of all life, and decried

the disastrous effect upon men, as well as beasts, when human bellies have no ears to hear the agonized cries of the doomed. Domitian, the Roman emperor, as Seneca says, started by killing flies and ended by killing men. This thought has been repeated many times and given new applications down to the present moment when vegetarians relate the diet question to the search for world peace. A sense of trusteeship in man's relation to all lower species is, in vegetarian thought, the beginning of a happy world order. Vegetarians further contend that theirs is also a practical philosophy, in light of the relationship between world population and the utilization of agricultural land. A vegetarian needs only about one-third as much land to support himself as does a meat eater.

Famous men of more recent times whose eating habits are praised in vegetarian annals include Count Tolstoy; Richard Wagner, the composer-conductor; Wilhelm Furtwängler, great interpreter of Beethoven and Brahms; and George Bernard Shaw, who chided his English compatriots for a misplaced confidence in beef tea and declared that meat eating was "cannibalism with its heroic dish omitted." In nineteenth-century America most of Emerson's circle, as well as Horace Greeley, Dr. Oliver Wendell Holmes, and the sprightly and scandalous Victoria Woodhull, all adopted vegetarian dining. In the present century Henry Morgenthau; John D. Rockefeller; Lucy Gaston, the nemesis of the cigarette; Gifford Pinchot, the conservationist; John H. Patterson, who invented high-pressure American salesmanship; and Horace Fletcher, the Great Masticator, who put the verb "to Fletcherize" in the dictionaries, all have nibbled at the vegetarian table. Probably best-known of all, next to Henry Ford who often wore a sprig of buckwheat in his lapel, is Johnny Weismuller of Tarzan fame. Weismuller, after only a few weeks on the meatless diet (according to news emanating from the Battle Creek Sanitarium), was able to hang up six world swimming records.

It is widely believed that Hitler, known for his sparse mode of eating, was a vegetarian. But the *Vegetarian News Digest*, which has looked into the matter, indignantly rejected any association of Der Führer with the

cause. "We have no information to indicate that he eliminated flesh foods from his diet for humanitarian reasons," the magazine concluded. The avoidance of meat or fish, it was pointed out, does not meet the definition of vegetarianism, "which is a philosophy of life and not a mere way of eating." This thinking would also exclude most of the Scotch and Irish populations who, as late as the nineteenth century, ate the vegetarian way, but not by choice.

Vegetarians have often been chided for being cranky and singular. Their tormentors have teased them by pointing out that if a cruel and relentless war were not waged on bean beetles, cabbage worms, aphids, and leaf hoppers, there soon would be no vegetables and no vegetarians to eat them. One wonders, too, what would happen to the productivity of the land if it were no longer dressed with bone meal and animal manures. Because of the humor and even hostility directed toward the vegetarian way of life by the "gentile" world, members of the faith tend to yard up for creature comfort in societies and lecture halls, and at harvest-festival dinners where they dine enthusiastically on soybean cutlets, carrot pie, and alfalfa tea. They meet in the pages of coterie magazines, often advertising for compatible mates: "Vegetarian woman wishes to correspond with spiritually oriented vegetarian man, 40 to 55."

Vegetarians tend to marry vegetarians. Exogamous unions are called "mixed marriages." In a number of instances, vegetarians have withdrawn from the frenetic world of flesh eaters into quasi-religious communities. One seriocomic venture was the Octagon Settlement scheme in which an idealistic group, who gave their occupations as blacksmith, tailor, librarian, widow, printer, hairdresser, tinsmith, colporteur, professor of music, water-cure doctor, and a few farmers, attempted to set up a colony on the Neosho River, near Fort Scott, Kansas. To the rhetorical question posed by their leader, the Reverend Henry Stephen Clubb, "Is Edenic Life Practical?" the answer turned out to be *no*. At least in Kansas.

Oregon and Florida have also been suggested as suitable sites for vegetarian colonizing; and a few years ago, a Dr. J. Waterman Rose,

rector of the Bronx Vegetarian enter, drew up plans for a vegetarn city, where it would be illegal for e residents to eat meat, a modern stance of sumptuary legislation at ast as bizarre as Prohibition. Dr. se's new town, to be called Vegenia or Vegetaria, was to be located ar Middletown, Connecticut. But e idea died on the vine.

There are more vegetarians in the nited States today than ever before, ch responding individually to me combination of the emotional, oral, or physiological arguments lvanced in support of the movement's mystique. They patronize ygienic havens such as the eightre Shangri-La Health Resort at onita Springs, Florida, which offers fasting, mental and emotional oise, discussion groups, nude sunathing, shuffleboard courts, and atercycles. Shangri-La serves oranically grown fruits, but no meat r dairy products. There is, too, a ational network of health-food ores and mail-order firms that suply fruit juicers and vegetable raters; soya cookies; roast, ground andelion roots; unbleached nuts; utrition charts; unsprayed rose ips; and the writings of the late ymon Gould, who put the American egetarian Party into politics and imself ran for President.

Vegetarianism remains, at bottom, form of sensibility despite its "scintific" trappings. It has undoubtdly influenced the large, uncomnitted public which, while it appreiates the satiety value of prime oast beef and has never seen the inide of an abattoir, yet is ill at ease bout calories, cholesterol, and crulty to animals.

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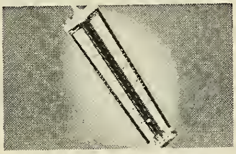

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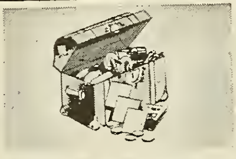

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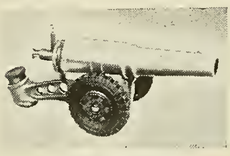

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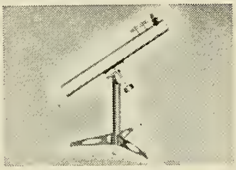

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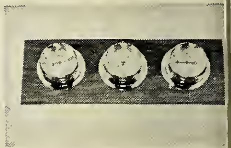

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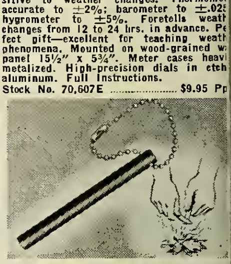

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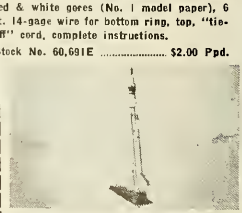

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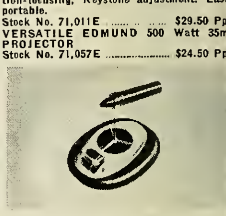

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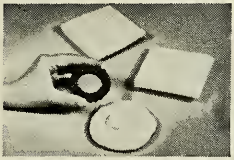

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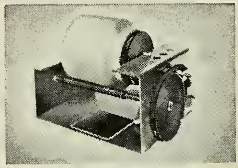

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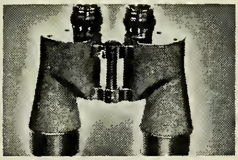

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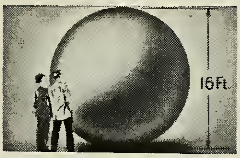

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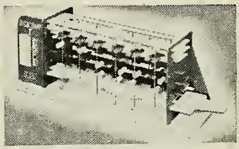

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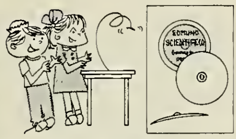

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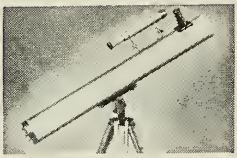

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AN ILLUSTRATED ELEMENTARY CLASSIFICATION OF MINERALS, ROCKS AND FOSSILS. H. Curwen. Pergamon Press, New York, 1965.

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CAVE LIFE ON THE PALOUSE. G. H. Grosso. *Natural History*, February, 1967.


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On Corcoran Street in Washington, D.C., Mrs Emmanuel Levine (left) and her neighbors—some black and some white—found homes all aroun them being condemned. They solicited private capital, restored, renovated... and before long the homes were uncondemned. Then they turne a rubbishy vacant lot into a pocket park with playground equipment and a 48-foot mural by Lloy McNeil of Howard University.

The Conservation Commission of Glastonbury Conn., headed by Mrs. Elizabeth Brown (center left), proposed a park for a still vacant parcel o land, but the project bogged down in debate. Voters became confused and the idea just abou died until the League of Women Voters and others joined Mrs. Brown's group. Money was raised, a mail campaign launched and each voter contacted. The park won by a squeak, but now, the town wouldn't give it up.

When urban sprawl threatened Champaig and Urbana, Illinois, Mrs. Susan Stone (cente right), her neighbors and fellow members of th Champaign County Development Council Foundation stumped for open park areas, fought fo better development planning and even went t Washington. Their masterpiece—planting mile of young shade trees along a major street—wa financed, in part, by selling buttons saying, "Lov Trees".

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